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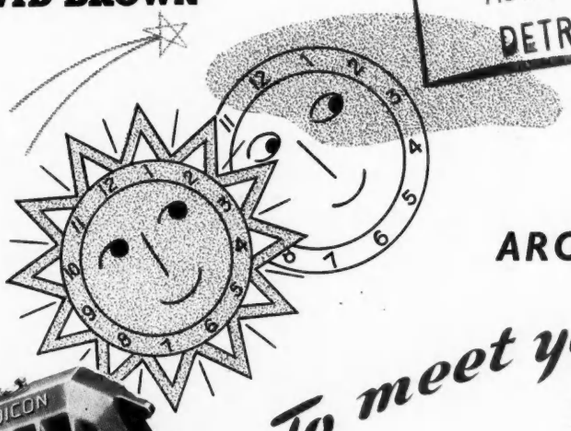

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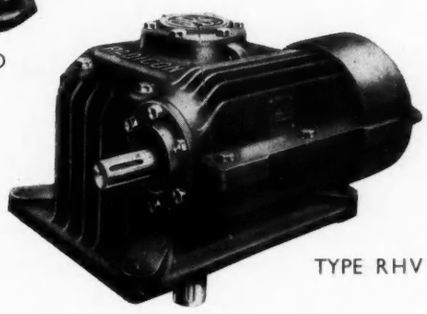

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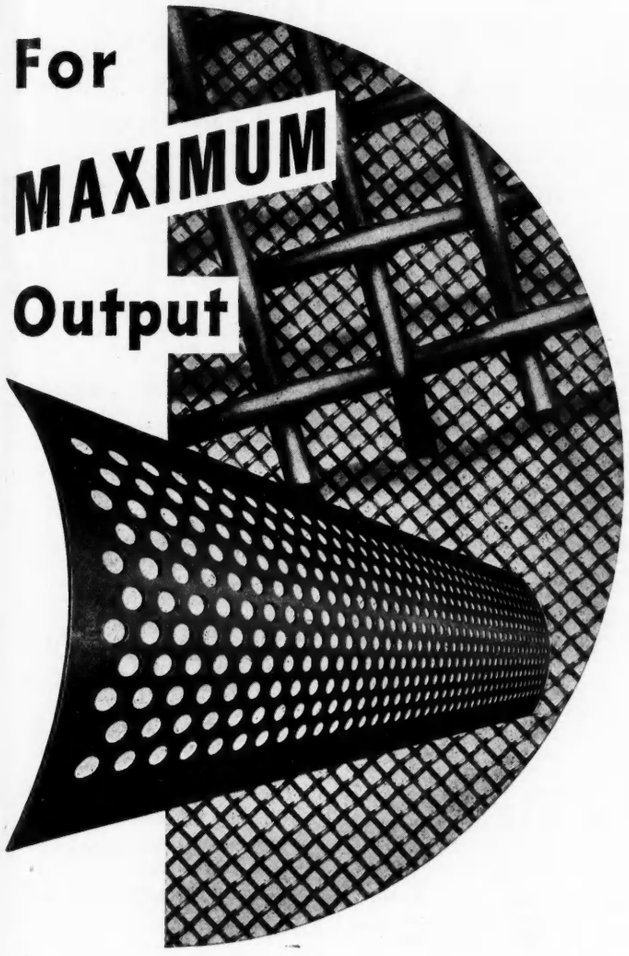

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THE ENGINEER

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NOTICE TO READERS

All letters intended for insertion in "The Engineer" or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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***Urgent advertisements may be telephoned to* CENtral 4565.**

E. R.

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

TO BE SOLD BY AUCTION

AUCTION PROGRAMME

		Main Location of Stores	Auctioneers
August 22	Miscellaneous stores	Returned Stores Depot, British Railway Sidings, Colley Lane, Bridgwater. (Sale at Royal Clarence Hotel.)	J. H. PALMER & SONS, (Dept. L), Bank Chambers, Burnham-on-Sea, Somerset. (Tel. 2326.)
August 28–30	*Machine tools and miscellaneous stores, including a large number of sewing machines	Central Ordnance Depot, Old Dalby, Melton Mowbray, Leicestershire. (Sale at Melton Mowbray.)	SHOULER & SON (Dept. L), 1 Norman St., Melton Mowbray, Leicestershire. (Tel. 81.)
September 4	Miscellaneous Stores	General Stores Sub-Depot, Longtown, Nr. Carlisle	HARRISON & HETHERINGTON LTD.(Dept. L), Botchergate, Carlisle. (Tel. 26292/3.)
September 3–6	Vehicles and lifting and earth moving equipment	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel. 47271.)
September 10–12	Vehicles, machine tools and miscellaneous stores	M.O.S. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18	FULLER, HORSEY SONS & CASSELL (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel. Royal 4861.)

* Machine tools and miscellaneous stores to be sold at Auction Assembly Rooms, 1, Norman Street, Melton Mowbray, Leics., on August 28–30 will include lathes, radial and other drills, pneumatic hammers, universal millers and shapers, table surface grinders, tool room grinders, air compressors, arc welders, 34 H.P. diesel engines, washing pumps, engravers, 630 industrial sewing machines, woodworking and sheet metal working machines, cotton sheeting and radio, etc.

CATALOGUES (6d. each—P.O.s only) available from the Auctioneers shown above.

E975 3

AUCTIONEERS & VALUERS

By order of the DIRECTORS of Messrs. W. H. ALLEN SONS & CO., LTD., who have discontinued the Foundry section of their business.

Messrs.

FULLER, HORSEY,

Sons & Cassell

have been instructed to offer for SALE by AUCTION in Lots on the Premises, QUEENS ENGINEERING WORKS, BEDFORD, on TUESDAY, 27th AUGUST, 1957, at 11 a.m. precisely :

FOUNDRY PLANT

including two 6-ton CUPOLAS, two Blast Fans, five BLACK SEAM coke-fired non-ferrous Furnaces from 2000 lb. to 400 lb. Oil-fired Mould and Core Drying Stores, Priestman Grab, seven Ladles up to 10 tons capacity. ELECTRO MAGNETIC SEPARATOR ; SENIOR SAND SLINGER, Sand Conveyors and Hopper, Sand Mills, Pneulec Herman 4000 lb. pneumatic MOULDING MACHINE, six McNab Moulding Machines, three Pneulec Herman portable Sand Mixers, Fettling Grinders, 400 tons FOUNDRY BOXES, WEIGHTS and PLATES, steel foundry boxes, 50 tons PIG IRON, 20 tons NON-FERROUS METAL INGOTS, 150 tons CAST IRON SCRAP, Electric and Manual Monorail Cranes, lifting tackle and numerous other effects.

Catalogues, when ready, may be obtained of Messrs. FULLER HORSEY SONS & CASSELL, Industrial Auctioneers & Valuers, 10, Lloyd's Avenue, London, E.C.3. E7841

PUBLIC APPOINTMENTS

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

SHAKESPEARE STREET, NOTTINGHAM

Principal : D. A. R. CLARK, M.Sc. (Tech.), M.I.Mech.E.

HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING

Applications are invited from persons with high academic qualifications and wide industrial experience for the post of HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING. Both educational and research experience are essential. Ability to initiate and develop research work in accordance with the policy of the College is of importance.

The Department will be moving into new accommodation within the next few months and much new equipment will be added to substantial equipment now available.

The post is a Grade III Departmental Headship, for which the salary scale is £1600 by £50 to £1750 per annum.

Further particulars and form of application may be obtained from the Principal. Completed forms should be returned not later than 30th August, 1957. E7856

SINGAPORE POLYTECHNIC

SENIOR LECTURER IN MECHANICAL ENGINEERING

The Board of Governors invites applications from persons with a suitable Engineering Degree and/or Graduate Membership of an appropriate Engineering Institution, with, preferably, good experience in both industry and in technical teaching.

It is intended that the department should offer courses leading to the examination of the City and Guilds of London Institute in Machine Shop Engineering, Pattern Making, Motor Vehicle Service, Electrical Installations, Telecommunications, Welding, &c., and courses of the National Certificate Type in Electrical and Mechanical Engineering. The most important duty, at first, will be helping to equip the new buildings now in course of erection.

Salary, incorporating all allowances : M$1800–M$50–M$1950 per month. The Malayan Dollar is 2s. 4d. Sterling.

Appointments will be on contract for six years with the option of renewal for a further three years. Insurance scheme, 5 per cent from staff, 15 per cent from college; accommodation, including heavy furniture at moderate rental; free medical attention, free passages for overseas persons appointed, wives and up to 3 children under 18 on first appointment, leave and completion of service ; home leave at the rate of two months per year's service ; maximum tour two years.

Application forms (4 copies) and further information obtainable from the Council for Overseas Colleges, 1, Woburn Square, London, W.C.1. Closing date 31st August, 1957. E7912

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

SHAKESPEARE STREET, NOTTINGHAM

ASSISTANT GRADE B IN CIVIL ENGINEERING

Applications are invited for the post of ASSISTANT GRADE B IN CIVIL ENGINEERING.

Salary in accordance with the Burnham Technical Scale as follows :—

£650 by £25 to £1025 per annum. Additions include Degree allowance of £75 per annum (or £125 for good Honours Degree), up to three increments of £25 for training in approved cases and incremental allowance for industrial experience after age 21, and war service.

Further particulars and form of application may be obtained from the Principal. Completed forms should be returned not later than 30th August, 1957. E7860

PUBLIC APPOINTMENTS

NATIONAL COAL BOARD

SOUTH WESTERN DIVISION

CIVIL AND/OR STRUCTURAL ENGINEERS

Applications are invited from experienced and qualified CIVIL and/or STRUCTURAL ENGINEERS for appointments in the Divisional Chief Civil Engineer's Department in the South Western Division of the National Coal Board.

Duties will include the design, documentation and control of the wide variety of major civil engineering work involved in the surface reorganisation of collieries and ancillary undertakings.

Candidates should have a good knowledge and understanding of industrial work, including industrial structures and buildings, roads and railways, earthworks, foundations and drainage, &c., and should be capable of the rapid and reliable execution of the duties outlined above.

Salary, according to experience and qualifications, will be within one of the following ranges : £975–£1650, £925–£1425, £800–£1225.

Applications, which should contain full particulars of age, experience, qualifications, and positions held, should be sent to the Divisional Chief Staff Officer, National Coal Board, Cambrian Buildings, Mount Stuart Square, Cardiff, by the 23rd August, 1957. Please quote Staff Agency No. 359. E7867

BOLTON AND DISTRICT JOINT SEWERAGE BOARD

APPOINTMENT OF PRINCIPAL ASSISTANT ENGINEER

Applications are invited for this appointment at a salary within the range £1300 by £50 to £1500.

The appointment, which is not on the Board's establishment, is for a minimum period of five years, is superannuable and subject to medical examination.

Applicants must be corporate members of the Institution of Civil Engineers and a University Degree would be an advantage.

Commencing salary will be according to qualifications and experience.

The person appointed will be responsible, under the direction of the Engineer to the Board, for the design and supervision of the Board's major capital works, including a new disposal plant and large trunk sewers. Experience in this field is essential.

Application forms, obtainable from me, are to be returned by 6th September.

Please quote reference B.E. 65.

PHILIP S. RENNISON,
Clerk to the Board.

Town Hall, Bolton. E7880

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

PLANT ENGINEERING DIVISION

YOUNG ELECTRICAL ENGINEER

A young ELECTRICAL ENGINEER is required for the Plant Engineering Division of the above Association for development work having the primary objective of automating steelworks plant. Applicants should preferably have an Honours Degree and an elementary knowledge of feedback engineering. An interest in digital and analogue servo techniques and electrical transient phenomena would be an advantage. The appointment is in the B.I.S.R.A. Electrical Control Team and the work is intensely interesting as well as vital to the steel industry. Salary will be rapidly progressive for the right man. A contributory superannuation scheme is in being and the work, which entails visits to steel works, will be based at our London laboratories.—Written applications only, quoting "E.8," to the Personnel Officer, B.I.S.R.A., 11, Park Lane, London, W.1. E7885

LONDON TRANSPORT

CIVIL ENGINEER

London Transport require CIVIL ENGINEER, preferably between ages 35 and 50, with wide experience, both in design and carrying out of heavy engineering works (i.e. earthworks, drainage, bridging, retaining walls, heavy foundations, reinforced concrete and tunnelling) ; experience in general railway constructions advantageous.

Candidates should be Chartered Civil Engineers, fully capable of organising and directing a section of the Drawing Office in preparation of schemes, estimates, design, contract drawings, bills of quantities and specifications, and should have kept themselves abreast of modern design techniques.

Salary range : £1210 to £1420. Medical examination ; free travel.

Applications within 7 days to Recruitment and Training Officer (F/EV 646), London Transport, 55, Broadway, S.W.1. E7833

NATIONAL COAL BOARD

SOUTH WESTERN DIVISION

SENIOR ENGINEERING DRAUGHTSMAN

The National Coal Board, South Western Division, invite applications for the post of SENIOR ENGINEERING DRAUGHTSMAN in the Divisional Carbonisation Department, Nantgarw, Glam.

Applicants should possess knowledge of plant layout, drainage, sewerage, tanks, gantries, conveyors, structural steelwork, &c.

Salary range £715–£965 per annum.

Please quote Staff Vacancy No. 352.

Full particulars of age, qualifications, experience and positions held, together with details of present post and salary, should be sent to the Divisional Chief Staff Officer, National Coal Board, Cambrian Buildings, Mount Stuart Square, Cardiff, by 20th August, 1957. E7866

PUBLIC APPOINTMENTS

WARWICK RURAL DISTRICT COUNCIL

WESTERN AREA WATER SUPPLY—CONTRACTS NOS. 9 AND 10

LEEK WOOTTON SEWERAGE AND SEWAGE DISPOSAL—CONTRACT NO. 11

APPOINTMENT OF RESIDENT ENGINEER

Applications are invited for the above appointment, to supervise the following works, all within 8 miles of Warwick.

CONTRACT No. 9

The construction of two 200,000 gallon reinforced concrete water towers and a borehole pumping station, alterations to an existing pumping station and the installation of pumping equipment.

CONTRACT No. 10

The laying of 31 miles of asbestos cement water mains, 3-inch to 12-inch, 3½ miles of spun iron water mains, 3-inch to 6-inch, and over 1000 service connections.

CONTRACT No. 11

The laying of 1¾ miles of 6-inch salt-glazed ware sewers and ¼ mile of asbestos cement sewers and the construction of sewage disposal works for 1300 people.

The three Contracts, which will run simultaneously, will be under the direction of the Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 18, Queen Anne's Gate, Westminster, S.W.1. One or more assistants will be appointed.

The salary is £1250 per annum and the appointment, subject to satisfactory service, will last approximately 2 years and will be terminable by 2 months' notice on either side. Housing will be available and a mileage allowance will be paid for the use of the successful applicant's motor-car whilst used on official business.

Applicants, who should be Associated Members of the Institution of Civil Engineers, or have comparable qualifications, and must have had experience of similar work, should apply in writing to the undersigned not later than 20th August, 1957, giving full particulars of age, qualifications and experience, and enclosing copies of not less than two recent testimonials.

T. W. H. WATKISS,
Clerk of the Council.

Council Offices,
23, Waterloo Place,
Leamington Spa. E7688

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

CAPENHURST, CHESTER

MECHANICAL SERVICES ENGINEER

A vacancy exists with the Research and Development Branch of the Industrial Group of the United Kingdom Atomic Energy Authority at Capenhurst Works, Capenhurst, Chester.

DUTIES :

To be responsible, to the Services Engineer, for the installation and maintenance of all mechanical and civil engineering services in a large, physics, chemical and engineering laboratory.

QUALIFICATIONS AND EXPERIENCE :

Applicants must have served a recognised engineering apprenticeship and be Corporate Members of a Senior Engineering Institution or have equivalent qualifications. A sound knowledge and experience of maintenance of a wide variety of engineering plant and equipment is essential, whilst a knowledge of civil engineering is desirable.

Salary :

£775 (at age 25)–£1210 p.a.

A contributory pension scheme is in operation.

An Authority house for renting by the successful candidate, if married, may be available in due course, or, alternatively, substantial assistance may be given towards legal expenses incurred in private purchase.

Send a postcard for an application form, quoting reference 1997, to the Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, Warrington, Lancashire. Closing date, 26th August, 1957. E7831

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HARWELL

ENGINEER

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Corporate membership of a Senior Engineering Institution or equivalent qualification.

£1235–£1655 (Engineer II).

Housing, superannuation and other excellent conditions.

Send postcard by 16th August, 1957, for further details and an application form to Group Recruitment Officer (801Y/25), A.E.R.E., Harwell, Didcot, Berks. P7815

NATIONAL COAL BOARD

EAST MIDLANDS DIVISION CARBONISATION DEPARTMENT

ENGINEERING DRAUGHTSMAN

Applications are invited for the post of ENGINEERING DRAUGHTSMAN at the Carbonisation Department Headquarters, Chesterfield. Salary range £655 to £765 per annum. Superannuation scheme. Five-day week.

Applications, giving details of experience and training, should reach the Administrative Officer, P.O. Box 16, Chesterfield, quoting C.S.V.83, not later than Saturday 17th August, 1957. E7744

PUBLIC APPOINTMENTS

NEW ZEALAND MINISTRY OF WORKS

PROFESSIONAL & TECHNICAL STAFF

The Ministry of Works, New Zealand, invites applications for the following vacancies on the permanent staff. Positions, qualifications desired and commencing salaries are as follows :—

CIVIL ENGINEERING DIVISION.

1. ENGINEERS.—Corporate Membership of the Institution of Civil Engineers, London. Commencing salaries from £895 to £1465 per annum.

2. ASSISTANT ENGINEERS.—A University Degree in Civil Engineering which gives exemption from Final Parts I and II of the A.M.I.C.E. examination or an equivalent examination. Commencing salaries from £810 to £1000 per annum.

3. ENGINEERING ASSISTANTS.—General Certificate of Education standard or equivalent and eight years' practical experience. Commencing salaries £810 to £1080 per annum.

4. DRAUGHTSMEN.—Ordinary or Higher National Certificate or equivalent and at least three years' experience at the drawing board. Commencing salary up to £1150 per annum in accordance with qualifications and experience.

MECHANICAL ENGINEERING DIVISION.

5. MECHANICAL & ELECTRICAL ENGINEERS.—Corporate Membership of the Institutions of Mechanical or Electrical Engineers, London, whichever is appropriate. Commencing salaries £895 to £1465 per annum.

6. BUILDING SERVICES ENGINEERS.—Corporate Membership of the Institution of Mechanical Engineers or of the Institution of Heating and Ventilating Engineers, London. Commencing salaries £895 to £1465 per annum.

7. ASSISTANT MECHANICAL, ELECTRICAL OR BUILDING SERVICES ENGINEERS.—A University Degree in Mechanical or Electrical Engineering or Graduate Membership of the above Institutions. Commencing salaries £810 to £1000 per annum.

8. MECHANICAL, ELECTRICAL OR BUILDING SERVICES DRAUGHTSMEN.—Ordinary or Higher National Certificate in Mechanical or Electrical Engineering or equivalent examination, and at least three years' experience in draughting, design and calculations. Commencing salaries £720 to £1000 per annum.

Inquiries, mentioning this paper and quoting reference No. 3/74/133, also stating the type and number of position sought, should be addressed to the High Commissioner for New Zealand, 415, Strand, London, W.C.2. Full details of duties, experience desired, and general information on the conditions of employment in the New Zealand Public Service, together with application forms, will then be furnished. E7820

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

RESEARCH AND DEVELOPMENT BRANCH

SENIOR ENGINEER/PHYSICIST

A vacancy exists with the Research and Development Branch of the Industrial Group of the United Kingdom Atomic Energy Authority at Windscale Works, Sellafield, Calderbridge, Cumberland.

DUTIES :

To take charge of a team engaged on experimental work in the Windscale and Calder reactors, which covers a wide range of problems concerned with the Authority's advanced reactor projects. The essential duties are of an engineering nature entailing responsibility for the design, development and installation of experiments which, in some cases, are effectively pilot plant installations. This post offers a unique opportunity to work in the forefront of nuclear power developments.

QUALIFICATIONS AND EXPERIENCE :

Applicants must have served a recognised engineering apprenticeship and hold Corporate Membership of a Senior Engineering Institution, or have an Honours Degree in Physics, or hold equivalent qualifications. It is essential that applicants should have design experience, a sound and wide engineering background, and an original approach to problems. A knowledge of reactor technology or reactor physics is not required.

SALARY :

Will be assessed within the scale £1705–£1980 p.a.

A contributory pension scheme is in operation.

An Authority house for renting by the successful candidate, if married, may be available, or, alternatively, substantial assistance may be given towards legal expenses incurred in private purchase.

Send a postcard for an application form, quoting reference 1980, to the Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, Warrington, Lancs.

Closing date : 19th August, 1957. E7817

CENTRAL ELECTRICITY AUTHORITY

EASTERN DIVISION

SENIOR DRAUGHTSMEN (MECHANICAL)

Applications are invited for the following appointments : SENIOR DRAUGHTSMEN (Mechanical), Generation (Construction) Department at Divisional Headquarters.

Salary N.J.B., Schedule "D," Grades 4/5, £800–£1045 per annum.

The commencing salary will depend upon experience and qualifications, but will be within the above range.

Applicants must have had experience in mechanical plant layout, pipework design.

Applications, stating age, qualifications, experience and present position, should be addressed to the Controller, Central Electricity Authority, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts.

W. N. C. CLINCH,
Controller.

E928

Classified Advts. continued on page 4

PUBLIC APPOINTMENTS

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

RESEARCH AND DEVELOPMENT BRANCH

ASSISTANT DESIGN ENGINEER

A vacancy exists with the Research and Development Branch of the Industrial Group of the United Kingdom Atomic Energy Authority at Windscale Works, Sellafield, Calderbridge, Cumberland.

DUTIES : to undertake design studies for mechanical engineering projects, including experimental equipment for investigating problems arising from the development of future reactor systems.

QUALIFICATIONS AND EXPERIENCE : Applicants must have served a recognised engineering apprenticeship and possess a Higher National Certificate, in Mechanical Engineering, or have equivalent qualifications. Several years' experience in a drawing-office is essential. Previous experience of heat transfer calculations and designing of experimental equipment would be advantageous.

SALARY : will be assessed within the scale £795–£1210 p.a.

A contributory pension scheme is in operation.

An Authority house for renting by the successful candidate, if married, may be available, or, alternatively, substantial assistance may be given towards legal expenses incurred in private purchase.

Send a postcard for an application form, quoting reference 1988, to the Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, Warrington, Lancs.

Closing date, 19th August, 1957. E7816

CIVIL SERVICE COMMISSION

CIVIL ENGINEERS; STRUCTURAL ENGINEER

The Civil Service Commissioners invite applications for pensionable posts.

Age at least 25 and under 35 on 1st January, 1957, with extension for regular Forces service and appropriate civil service.

Candidates must (i) have achieved Corporate Membership of the Institution of Civil Engineers or the Institution of Structural Engineers for the Structural Engineer post, and, for some posts, have qualified in certain subjects, or (ii) have passed, or been exempted from, examinations necessary for obtaining Corporate Membership ; such candidates would be expected to qualify under (i) in due course. Professional experience expected.

London salary scale (men) £765 (at age 25) to £1190. Starting salary according to age up to £1030 at 34 or over. Lower rates outside London. Prospects of promotion to higher grades on salary scale £1215–£1640 and £1690–£1950 and above. Women's salaries lower, but being raised to reach equality with men's by 1961.

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S64–65/57.

Interview Boards held at intervals, as required. Early application advised. E7837

ADEN PORT TRUST

ASSISTANT MAINTENANCE SUPERINTENDENT

The Board of Trustees invite applications for the post of ASSISTANT MAINTENANCE SUPERINTENDENT, not more than 36 years of age, who should have served a recognised engineering apprenticeship and should possess a 1st Class (Steam) Ministry of Transport Marine Engineer Certificate. Preference will be given to candidates with a combined 1st Class Steam and Diesel Certificate who have had workshop experience since qualifying : such candidates will be considered for a higher starting salary.

Salary of the appointment is £1450 by £50 to £1950 per annum under agreement. Free unfurnished quarters and medical attention. Gratuity or Pension Fund.

For full details apply on a postcard to Personnel Dept., Consulting Engineers and Agents, Aden Port Trust, 1, Lygon Place, Grosvenor Gardens, London, S.W.1, or telephone SLOane 0431. E7731

SURREY COUNTY COUNCIL

MECHANICAL ENGINEERING ASSISTANTS

Applications invited for following appointments :

(1) MECHANICAL ENGINEERING ASSISTANT, GRADE III, £656–£784 2s. 6d. p.a. plus £30 p.a. London allowance. Should hold National Certificate and be experienced in layout and design of heating and hot water services in buildings.

(2) MECHANICAL ENGINEERING ASSISTANT, GRADE II, £609 17s. 6d.–£691 17s. 6d. p.a. plus London allowance up to £30 p.a. Preferably with some experience in layout and design of heating and hot water services in buildings.

Full details, present salary and three copies testimonials to County Architect, County Hall, Kingston, as soon as possible. E7904

COUNTY COUNCIL OF THE WEST RIDING OF YORKSHIRE

STRUCTURAL ENGINEER

STRUCTURAL ENGINEER urgently required.

Senior Assistant, experienced in design of steelwork for buildings. Must be A.M.I.Struct.E. or equivalent. Salary £727 15s.–£907 2s. 6d.

Alternate Saturdays free. Canteen facilities.

Application forms may be obtained from the County Architect, Bishopgarth, Westfield Road, Wakefield, and should be returned not later than the first post on the 16th September, 1957. E7824

PUBLIC APPOINTMENTS

CIVIL SERVICE COMMISSION

MECHANICAL AND ELECTRICAL ENGINEERS

MECHANICAL and ELECTRICAL ENGINEERS in various Government Departments. The Civil Service Commissioners invite applications for pensionable posts in a wide variety of mechanical and electrical engineering duties.

Candidates must be under 35 on 1st January, 1957, with extension for regular service in H.M. Forces and appropriate civil service. For the Post Office they must be at least 21, for the Ministry of Supply, and Ministry of Transport and Civil Aviation (Civil Aviation Organisation) at least 23 ; for other posts at least 25 on that date.

The achievement of Corporate Membership of one of the professional institutions—Mechanical Engineers, Electrical Engineers, or Civil Engineers—is essential for most of the posts, but for some posts Associate Fellowship of the Royal Aeronautical Society or (in the Post Office) an Honours Degree in Engineering or Physics will be accepted. Candidates will, however, be admitted, provisionally, who have passed, or have exemption from, the appropriate Sections of the examinations for the stipulated Associate Membership. Exceptionally, a candidate otherwise qualified by evidence of high professional attainment may be admitted. Relevant training and practical experience is expected.

London salary (men) £765 (at age 25) to £1190. Starting salary according to age up to £1030 at 34. Candidates entering below age 25 will start at salaries varying from £565 at age 21 to £685 at age 24. Prospects of promotion to higher grades on salary scales £1215–£1640 and £1690–£1950. Somewhat lower in the provinces. Women's scales lower, but being improved to reach equality with the men's scales by 1961.

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S 85/57. Application forms should be returned by 30th September, 1957. Earlier applicants may be interviewed before that date. E7822

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT

WOOLWICH COMMON

ENGINEERS

ENGINEERS required by The Atomic Weapons Research Establishment, Woolwich Common, to control staff engaged on one of the following :—

(a) Production planning and control. The successful applicant will also be required to contribute to the development of prototype electronic equipment.

(b) The development of electronic equipment and mechanical devices and the investigation of new and novel manufacturing techniques.

A recognised engineering apprenticeship or equivalent training and A.M.I.Mech. or E.E. required. A thorough knowledge of electronic development and/or production methods essential.

Salary £1333 8s.–£1755 p.a. (male).

Contributory superannuation scheme.

Postcards for application forms to the Senior Recruitment Officer at A.W.R.E., Aldermaston, Berks. Please quote ref. 1555/25. E7818

WEST CUMBERLAND HOSPITAL MANAGEMENT COMMITTEE

WORKINGTON INFIRMARY

ASSISTANT ENGINEER

Applications are invited for the above post, which is a new one. A new automatic oil-fired Boilerhouse is now under construction and the Engineer will be responsible for the operation of this Boilerhouse and for the other engineering services at Workington Infirmary and at the nearby Ellerbeck Hospital. He will eventually be responsible to the Superintendent Engineer, when appointed in due course. Whitley Council conditions, salary £555–£675. A house may be available at a reasonable rent.

Applications, preferably from persons holding the O.N.C. in Mechanical Engineering (including Heat, and preferably endorsed in Principles of Electricity), or a Second Class Certificate of Competence in Marine Engineering, or similar Naval Certificate, giving full details of qualifications and experience, and the names of three referees, should be forwarded to the Group Secretary, Workington Infirmary. E7839

LONDON TRANSPORT

ENGINEERING ASSISTANTS

London Transport require ENGINEERING ASSISTANTS for Bridges and Structures Office. Applicants should be Graduates or studying for A.M.I.C.E., or be Senior Structural Draughtsmen with several years' experience of design work. Salary range : £790–£880. Free travel, medical examination.

Applications within 7 days to Recruitment and Training Officer (F/EV 647), London Transport, 55, Broadway, S.W.1. E7834

COUNTY BOROUGH OF EAST HAM

ASSISTANT ENGINEER (MECHANICAL)

ASSISTANT ENGINEER (MECHANICAL).—Grade III, £656 to £784 2s. 6d.

London Weighting is paid in addition. Salary in excess of the minimum may be paid, according to qualifications and experience.

A subsistence allowance may be granted over a reasonable period to the person appointed if unable to obtain suitable housing accommodation, necessitating the maintenance of two homes.

Further details and application forms returnable by 23rd August, 1957, from the Town Clerk, Town Hall, E.6. E7835

PUBLIC APPOINTMENTS

CENTRAL ELECTRICITY AUTHORITY

EASTERN DIVISION

CIVIL AND STRUCTURAL DESIGNER DRAUGHTSMEN

Applications are invited for the following posts at Divisional Headquarters, Cockfosters, adjacent to Cockfosters Station (Piccadilly Line) :—

CIVIL AND STRUCTURAL DESIGNER DRAUGHTSMEN

Salary : N.J.B., Schedule "D," within the range of Grades 4/5, £800 by £20 to £945 per annum, including London Weighting.

The commencing salary will depend on experience and qualifications.

New offices recently completed in pleasant surroundings, excellent working conditions. Canteen available. Sports and social club. Sick pay and superannuation schemes. Generous holidays.

The candidates appointed will be required to undertake civil and structural design work, and applicants should have had experience in the design and detailing of reinforced concrete structures for heavy plant, culverts, &c., and structural steelwork as applied to industrial buildings.

Applications, stating age, qualifications and experience, should be sent to the Controller, Central Electricity Authority, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts.

W. N. C. CLINCH,
Controller.
E974

LONDON TRANSPORT

CIVIL ENGINEERS

London Transport require a number of CIVIL ENGINEERS in connection with their New Works Programme ; preferably with a University Degree or Graduate Membership of a recognised professional Institution.

Applicants must have had experience in preparation of schemes, estimates, civil engineering design, contract drawings and documents and be capable of controlling staff and supervising works executed by contract. They must have had experience in some of the following types of civil engineering work—earthworks, drainage, bridging, retaining walls, heavy foundations, R.C. works, tunnelling, general railway construction.

Salary range according to ability, qualifications and experience, from £790 to £1155. Medical examination, free travel.—Applications within 14 days to Recruitment and Training Officer (F/EV 648) London Transport, 55, Broadway, S.W.1. E7915

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

FIRE RESEARCH STATION, ELSTREE, HERTS

ASSISTANT EXPERIMENTAL OFFICER

Department of Scientific and Industrial Research, Fire Research Station, Elstree, Herts, requires ASSISTANT EXPERIMENTAL OFFICER for research and testing on effect of fires on building materials and structures by use of large furnaces. Qualifications : G.C.E. "A" Level in two science or maths. subjects, or equivalent ; over age 22, H.N.C. or pass Degree in Engineering or equivalent, generally expected. Knowledge of design of structures desirable. Salary : men, £365 (age 18) to £805. Rather less for women, but equal pay scheme. Five-day week.—Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting E377/7A. E7870

CENTRAL ELECTRICITY AUTHORITY HEADQUARTERS

RESEARCH LABORATORIES, LEATHERHEAD

CIVIL ENGINEERS

Applications are invited for the appointment of CIVIL ENGINEERS at the Research Laboratories, Leatherhead, Surrey, to carry out investigations into the properties of pulverised fuel ash concrete, the applications of such concrete to civil engineering projects, and the further use of p.f. ash. Candidates should have a Degree or H.N.C. in Civil Engineering. Salary £550–£995 per annum, according to qualifications and experience.—Applications, stating age, experience, present position and salary, should be forwarded to D. Moffat, Director of Establishments, Winsley Street, London, W.1, by 31st August, 1957. Quote reference ENR/348. E7864

NATIONAL COAL BOARD

NO. 1 (WORKSHOP) AREA

CIVIL ENGINEERING ASSISTANT, CLASS 2

CIVIL ENGINEERING ASSISTANT, Class 2, required for Civil Engineering Department. Salary range : £725/£1075 per annum.

Applicants should have had at least two years' experience in a Design Office on structural work and general building construction. They should have passed some part of the qualifying examination of a recognised professional institution or at least be preparing to take such examination.

Applications, stating age, education and present post, to : Area Staff Manager, Todwick Grange, Nr. Sheffield, by 19th August, 1957. E7842

PUBLIC APPOINTMENTS

LONDON COUNTY COUNCIL

ASSISTANT RESIDENT ENGINEERS

Required, ASSISTANT RESIDENT ENGINEERS for civil engineering contracts (1) at Northern Outfall Works, Beckton, E.6 ; must be able to set out works and have previous site experience. (2) in N.W. London area, experienced in sewer construction in tunnel, concrete and cast iron segments. Salaries up to (1) £1057 and (2) £846.—Application form from Chief Engineer (57/50), London County Council, County Hall, S.E.1. (1443.) E7757

TENDERS

INDIA STORE DEPARTMENT

BORING MACHINES

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

1 No. UNIVERSAL HORIZONTAL, SURFACING, BORING, MILLING, DRILLING and TAPPING MACHINE, dia. of spindle 102mm., diameter faced 1372mm., size of table 1677 by 1066mm. (Ref. No. 2018/57/ENG.3).

1 No. GUN BORING MACHINE, single spindle, for drilling up to 50mm dia., boring and drilling up to 80mm. dia., max. length of workpiece 2500mm. (Ref. No. 2031/57/ENG.3).

1 No. HORIZONTAL BORING MACHINE, dia. of spindle 76mm., traverse of spindle 762mm., max. and min. distances from centre of spindle to table 812 and 50mm. respectively (Ref. No. 2051/57/ENG.3).

Tender schedules and specifications may be obtained from the above address at a fee of Ten Shillings per set, which is not refundable. Applications for Tender forms should state description of machine and corresponding reference for which schedules are required.

Tenders, complete with specifications, are to be submitted by Monday, the 30th September, 1957. E7844

INDIA STORE DEPARTMENT

TURRET LATHES

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

2 Nos. COMBINATION TURRET LATHES, height of centre 273mm., length of longitudinal automatic feed to turret saddle 1067mm., admits between spindle nose and turret face 1410mm., length of bed 3048mm.

1 No. COMBINATION TURRET LATHE, with patent preselecting headstock and covered bed for chuck work only, height of centre 222mm., admits between spindle flange and face of turret 1092mm., diameter of hole through spindle 66·7mm., length of longitudinal automatic feed to saddle 787mm., swing over stainless steel covers 406mm.

Tender schedules and specifications may be obtained from the above address at a fee of Ten Shillings, which is not refundable. The applications for Tender forms should state reference 2016/57/ENG.3.

Tenders, complete with specifications, are to be submitted by Monday, the 30th September, 1957. E7846

INDIA STORE DEPARTMENT

DIE SINKING MACHINE

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

1 No. UNIVERSAL DIE SINKING MACHINE, motor driven ; circular path of oscillating head adjustable 0 to 152mm., vertical travel of knee 457mm., face of column to centre of spindle 406mm.

Tender schedules and specifications may be obtained from the above address at a fee of Ten Shillings, which is not refundable. The applications for Tender forms should state reference 2014/57/ENG.3.

Tenders, complete with specifications, are to be submitted by Monday, the 30th September, 1957. E7845

INDIA STORE DEPARTMENT

AUTOMATIC SCREW MACHINE

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

SINGLE-SPINDLE AUTOMATIC SCREW MACHINE, capacity 36mm (1 13/32in.), complete with standard equipment—1 No.

Tender schedules and specifications may be obtained from the above address at a fee of Ten Shillings, which is not refundable. The applications for Tender forms should state reference 2072/57/ENG.3.

Tenders, complete with specifications, are to be submitted by Monday, the 30th September, 1957. E7847

INDIA STORE DEPARTMENT

DRAFT CASTING

The Director General of India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

	Quantity
DRAFT CASTING ...	900 (105 lb each)

Forms of Tender may be obtained from the above address on or after the 9th August, 1957, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m. on Thursday, 19th August, 1957.

Please quote reference No. 49/57/DB/Rly. 2. E7829

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guaranteed Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E721 B

FREE! Brohcure giving details of Courses in Mechanical and Production Engineering, Draughtsmanship, &c. for the A.M.I.MechE., A.M.I.P.E., City and Guilds and other Professional examinations. —E.M.I. Institutes, Dept. E30, London, W.4. (Associated with H.M.V.) E972 B

WORK STUDY.—Part-time (evening) 20 weeks' Diploma Course starts September 9th. Enrolments open now.—Details of this and five other courses, including full-time (six weeks) and correspondence, from School of Time and Motion Study, 29, Cork Street, W.1. Regent 0516. E7617 B

TECHNICAL HOME STUDY COURSES

For A.M.I.Mech.E.,
A.M.I.Chem.E., A.M.I.M.I.,
A.F.R.Ae.S., C. & G., &c.

OVER 50 FIRST PLACES and more than 2000 Passes have been secured by T.I.G.B. Students at Professional Engineering Examinations. We have a wide range of exclusive Home Study Courses in all branches of Engineering—Mcehanical, Electrical, Aeronautical, Automobile, Chemical, Gas, Radio, and Television, Draughtsmanship, &c. Textbooks, blueprints, &c., are provided and, if desired, fees may be paid by moderate instalments.—Write (stating subject of interest) for copy of 110-page Prospectus FREE and without obligation.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
(Dept. 76),
29, WRIGHT'S LANE, LONDON, W.8.
E102 B

UNIVERSITY OF MANCHESTER

The next Session commences on Thursday, 3rd. October, 1957 E7704 B

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED

A SENIOR ASSISTANT is required in the Chief Engineer's Department of a large group of companies with headquarters in West London. Preference will be given to men who are members of a professional Institute and who have knowledge of structural engineering. The post, which is permanent and pensionable, will carry a commencing salary of £1100/£1250, according to experience.—BOX No. E7914, "The Engineer." A

A U.K. COMPANY manufacturing small petrol and diesel engines has a vacancy for a SPECIAL REPRESENTATIVE for the South American area. The representative will be based in this country and will be required to make two or three tours of the area each year. Candidates must be experienced in the small engine sales field, and have some previous knowledge and experience of the South American market. Fluent Spanish essential, Portuguese desirable. Applications, giving a summary of qualifications and experience.—BOX No. E7884, "The Engineer." A

A VACANCY EXISTS with Smiths Motor Accessories, Ltd., for a FIRST-CLASS DESIGNER, with wide experience in the light and precision engineering field. The successful applicant may be a Graduate Mechanical Engineer with progressive outlook and at least seven years' design experience in a senior capacity, preceded by practical experience or apprenticeship. He will be required to produce complete prot-type designs to a specification, and contribute clear thought and new ideas.—Apply to Mr. D. H. Squire, Cricklewood Works, N.W.2 (GLA 3333). E7857 A

AN EXPANDING HEAVY CHEMICAL INDUSTRY has vacancies for GRADUATE ENGINEERS (Mechanical) in one of its factories on the East Coast of England for plant maintenance and construction work. Whilst a University Degree on Mechanical Engineering is preferred, consideration will be given to outstanding applicants possessing an equivalent qualification ; age up to 40. Salary in the range £900/£1335. Annual bonus and pension schemes, also assistance for married men with house purchase and removal expenses. Applications, which will be treated in the strictest confidence, to BOX No. E935, "The Engineer." A

AN IMPORTANT AGENCY HOUSE requires youngish first-class Mechanical Engineer, preferably unmarried, with several years' practical experience since qualifying and preferably including some civil engineering experience as visiting engineer for their large group of estates in Malaya. Duties comprise visiting estates, advice and assistance on installation, operation and maintenance of equipment for both rubber and tea manufacture, design of factory layouts, construction of smokehouses, coolie lines, bungalows, &c. Some schemes involve large expenditure. Good basic salary, high cost-of-living allowance, bonus out of annual profits, provident fund, to which company contributes 15 per cent and employee 10 per cent of basic salary, car allowance, six months' paid home leave at end of tour, local leave.—Full particulars of qualifications, experience and present salary, to BOX No. 754, Haddons, Salisbury Square, E.C.4. E7819 A

ASSISTANT ENGINEER required for the Mothers' Hospital (Salvation Army), Clapton, E.5, and for Relief Duty at the Eastern Hospital, a short distance away. A sound knowledge of mechanical engineering and of steam boiler, laundry and kitchen equipment is necessary. Salary : £605–£705 p.a.—Application form from Group Secretary, Hackney Hospital, E.9, for return by 21st August. E7861 A

ASSISTANT TECHNICAL ENGINEER required by prominent East London company engaged in the production of winding wires. Qualifications : Degree in Electrical or Mechanical Engineering or Corporate Membership of relevant Professional Institution. Please write to Personnel Officer.—BOX No. E1132, "The Engineer." A

SITUATIONS VACANT

AIR-CONDITIONING ENGINEER required to develop up this department of a Midland firm.—BOX No. E1111, "The Engineer." A

APPLICATIONS ARE INVITED from PROJECT ENGINEERS over 28 and having H.N.C. minimum qualification, for vacancies in the Development Engineering Department at Ferodo Limited. This is a senior staff appointment and candidates must have had experience in one or more of the following subjects :—

Special plant design, heating, ventilating and dust collection, production engineering and plant layouts, factory mechanical services layouts.

They will be responsible for handling the projects through initial investigation, preparation of estimates and reports, ordering plant and equipment and arranging for installation.

Write, giving details of age, previous experience and salary required, to the Personnel Manager Ferodo Limited, Chapel-en-le-Frith, Via Stockport. E7791 A

AREA ENGINEER (MECHANICAL), responsible to Mechanical Engineer for Planned Maintenance Routines, co-ordination and control of Capital Projects and availability of materials, increasing machine efficiency and reducing maintenance cost, control of craft Foremen, &c. Technical qualifications—Graduate or H.N.C.

JUNIOR ENGINEER (MECHANICAL), responsible to Mechanical Engineer for specific maintenance and project problems whilst being trained for the post of Area Engineer. Technical qualifications—Graduate or H.N.C., but O.N.C. considered in special circumstances.

Applicants should write, stating age, qualifications and experience, to the Personnel Officer (Staff), Pilkington Brothers Limited, St. Helens, Lancashire. E7836 A

ASSISTANT CONTRACTS MANAGER
required by
BRITISH OXYGEN WIMPEY LIMITED

Duties include responsibility for the placing of sub-contracts, progressing, scheduling and the co-ordination of all activities in the Contracts Department.

Applications are invited from suitably qualified persons who should be around 35 years of age with at least 5 years' commercial experience and preferably have an engineering background. A knowledge of Government Contract procedure would be an additional advantage.

The position, which is in the London area, is permanent, with contributory pension scheme, and offers a generous salary for a suitably qualified applicant of progressive outlook, possessing organising ability. Assistance will be available for movement exponses to a successful applicant living outside the London area.

Applications, which will be treated in the strictest confidence and containing full particulars of age, education, previous experience and salary required, should be submitted to Mr. D. G. Ely, Contracts Manager, British Oxygen Wimpey Ltd., 17, Monck Street, Horseferry Road, London, S.W.1. E7886 A

ATOMIC ENERGY.—Applications are invited by firm based in London and New York for a situation to cover the marketing in United Kingdom and Europe of essential equipment of British and American origin. Applicants should be around 30, have a University Degree in Engineering (or similar), a leaning towards organisation, and preferably some commercial or sales experience. After suitable training he should be able to work largely on his own and develop a new division. A commencing salary of around £750/£1250 is proposed, plus incentive scheme, expenses, pension, motor-car. Operating from London applicant would have the benefit of office and sales staff in principal U.K. cities and agents set up in Europe. Please submit full personal details.—BOX No. E7760, "The Engineer." A

BRITISH PETROLEUM COMPANY LTD. has a vacancy for a SHIFT ENGINEER at its Bunkering Installation at ADEN. Applicants, aged 28–35, must have at least O.N.C. and preferably a 1st Class M.O.T. Steam and Motor Certificate ; must have served full mechanical engineering apprenticeship followed by minimum of five years' diesel engine maintenance and operation. Attractive salary plus generous allowance in local currency, pension scheme, free passages out and home, free medical attention, good leave arrangements, kit allowance.—Write, giving full particulars, quoting F.534, to BOX 2010, c/o 191, Gresham House, E.C.2. E7902 A

BRITISH PETROLEUM COMPANY LTD. has vacancies in MIDDLE EAST for young MECHANICAL ENGINEERS for training in Oil Distribution Maintenance Engineering and Aviation Service Engineering. Applicants under 27 years of age must have at least H.N.C. in Mechanical Engineering and have served five years' workshop apprenticeship. Attractive salary plus generous allowance in local currency, free passages out and home, free medical attention, good leave arrangements. Kit allowance. Pension scheme.—Write, giving full particulars, quoting F.535, to BOX 2006, c/o 191, Gresham House, E.C.2. E7900 A

BRITISH PETROLEUM COMPANY LTD. has a vacancy for a CIVIL ENGINEER. Applicants, aged 35–45, must have A.M.I.C.E. and a Degree in Civil Engineering is desirable. Must have had sound all-round civil engineering experience with an industrial background including the design and construction of foundations for heavy and medium plant and of retaining walls, earth embankments, &c. Knowledge of Oil Terminal Installations and pipeline routing an additional advantage. Salary according to qualifications and experience, non-contributory pension fund, housing scheme. Removal expenses and settling-in allowances paid in certain cases.—Write, giving full particulars quoting H.3886B, to BOX 5380, c/o 191, Gresham House, E.C.2. E7889 A

BRUSH ELECTRICAL ENGINEERING CO., LTD., Loughborough, Leics., manufacturers of Steam and Gas Turbines and Electrical Equipment, have a vacancy for a young ASSISTANT METALLURGIST of Degree standard or equivalent qualification in Metallurgy. The duties cover general metallurgical examination of engineering materials, principally ferrous metals and alloys. This vacancy offers good prospects in an expanding organisation, and a good salary will be paid. The factory is situated in a pleasant Midland town, within easy reach of a number of cities. Conditions of service include a generous non-contributory staff assurance scheme.—Please apply to the Chief Personnel Officer. E7838 A

SITUATIONS VACANT

BRITISH PETROLEUM COMPANY LTD. has vacancy at its ADEN Refinery for a POWER STATION SHIFT CHARGE ENGINEER. Applicants must have had experience of operation of modern oil and gas-fired automatic combustion control high pressure boilers rating 160,000 lb./hr. at 650 p.s.i., 750 deg. F., with usual auxiliaries. Operation of steam turbines up to 10,000 H.P., water pumping sets up to 1·2 M.G./hr., and large capacity sea water evaporator plants. Knowledge of A.C. electrical generation an advantage. Preference given to candidates possessing M.O.T. Certificate (Steam). Age 30–35 years. Attractive salary, plus generous allowance in local currency, free passages, kit allowance, free medical attention, good leave arrangements, pension scheme.—Write, giving full particulars of qualifications and experience, quoting Reference F.210, to BOX 2002, c/o 191, Gresham House, E.C.2. E7901 A

BUILDING INDUSTRY
ENGINEER ESTIMATOR
Interesting position
in
NORTH WEST AREA

Fully experienced STRUCTURAL/CIVIL ENGINEER with knowledge of estimating and capable of practical design of concrete formwork. Position will entail liaison between Estimating and Construction Depts. in economic design of permanent structures and temporary works. Applicants should give all employment history and type of work undertaken, including, in confidence, present work, qualifications, education, age and approx. salary required should be included.—BOX No. E7905, "The Engineer." A

CHIEF ENGINEER required for Chemical Factory in Kent. Capable of maintenance of existing equipment and erection and fabrication of new plant. Please state salary required.—BOX No. E1130, "The Engineer." A

CHIEF ROLL DESIGNER, aged 35–45, required by large steel works. Applicants should be fully conversant with the designing of rolls for heavy and light mills, rolling rounds, billets, channels, angles, tees, &c., in a wide range of sizes. The position carries excellent prospects and a good salary will be paid to the right man. A pension scheme and free life assurance scheme are in operation. Write, giving full details of age, qualifications and previous experience.—BOX No. E7910, "The Engineer." A

CIVIL ENGINEER.—A senior vacancy exists within a leading engineering organisation for a man possessing a Degree in Civil Engineering. Must be fully experienced in civil work on large-scale industrial contracts. Salary up to £2000 p.a., according to age and experience. Please write full details, in strict confidence.—BOX No. E7764, "The Engineer."

CIVIL ENGINEERING DESIGNERS required by Westminster consulting engineers with experience in the design of one or more of the following : harbour and dock works, bridges, large dams, reinforced concrete and mass concrete structures. Salary according to experience. Five-day week, pension scheme, luncheon vouchers. Apply, stating age and experience.—BOX No. E7888, "The Engineer." A

CIVIL ENGINEERING DRAUGHTSMAN required by Albright and Wilson (Mfg.), Ltd., for their Central Engineering Department at Oldbury. Applicants should be within the age range 22–26 years. The duties will include the preparation of drawings of building and civil engineering works on varied new projects required by the company. Previous experience in drawing work concerned with reinforced and concrete foundations and some knowledge of surveying would be an advantage.—Apply in wiriting, giving details of age, qualifications and experience, to the Labour and Welfare Officer (ref. 387), Albright and Wilson (Mfg.), Ltd., P.O. Box 3. Oldbury, Birmingham. E7913 A

COMMERCIAL DIRECTOR.—Leading British company with extensive interests in U.K. and overseas, wish to appoint a Commercial Director. The company's interests lie mainly in the chemical field and the organisation specialises in contracting for large chemical plants. The appointment calls for a candidate with extensive technical and commercial experience in the negotiation of large contracts, preparation of specifications, estimates, cost control, buying, invoicing and legal procedure. The successful candidate would have a seat on the Board. Applicants should submit full details of experience and salaries earned, which will be regarded as strictly private and confidential.—BOX No. E1121, "The Engineer." A

COMMISSIONING ENGINEER

required, preferably with some practical experience in the operation of gas and liquid fuel-fired Industrial Furnaces of all types. A working knowledge of instruments and controls is also desirable and applicants should be prepared to travel. Salary commensurate with experience and qualifications. Pension scheme.—Apply, giving full details, to :

The Secretary,
PRIEST FURNACES LIMITED,
Longlands,
Middlesbrough,
Yorkshire. E7848 A

CONSULTING ENGINEERS have a vacancy for CIVIL ENGINEER, experienced in the exploratory work for, and subsequent design and construction of, large hydro-electric projects involving the construction of large impounding dams. Applicants must be Chartered Civil Engineers not less than 35 years old and must have several years' experience in a leading capacity as senior engineer on the investigation and construction of such projects. Salary from £1800 p.a. to £3000 p.a., according to status and experience. Applications, which will be treated as strictly confidential—BOX No. E1133, "The Engineer." A

DESIGNER/DRAUGHTSMEN, experienced in Jib Cranes. &c. Position offered, due to expansion of firm's activities, would be permanent, progressive, and would carry salaries commensurate with experience. Pension scheme.—Apply : Chief Engineer, Clyde Crane and Engineering Co., Mossend, Nr. Motherwell. E7874 A

SITUATIONS VACANT

DEPUTY CHIEF ENGINEER is required by a leading petroleum chemical firm. Preferably aged 35/45. Applicant must be fully qualified and have experience in large-scale continuous process plant. Some administrative experience is essential. Salary will be dependent on age and experience.—BOX No. E7728, "The Engineer." A

DESIGN DRAUGHTSMEN.—The British Drug Houses, Ltd., invite applications from suitably qualified men for interesting work in the Engineers Drawing Office, on special machines and plant layouts for the Light Chemical Industry. H.N.C. in Mech. Eng. and previous experience in this industry desirable but not essential. Men of mature age with suitable training and experience, would be considered. Five-day week, pension and profit-sharing schemes.—Write, stating age, experience and salary required, to Staff Manager, Graham Street, N.1. E7871 A

DESIGNER-DRAUGHTSMAN, with experience water-tube boilers, required for newly forming company, south of London. Good prospects and salary. —BOX No. E1080, "The Engineer." A

DESIGNER-DRAUGHTSMEN & DETAILERS wanted for work on chemical plant layout, vessel design and pipework, &c. Top salaries offered men with experience and maximum assistance in regard to housing. Grant towards removal expenses and living allowance until removal completed. Pension and insurance scheme, technical library, sports ground.—Apply, "ref. D," Staff Personnel Manager, Power Gas Corpn., Ltd., Stockton-on-Tees. E7738 A

DESIGNERS, DRAUGHTSMEN AND CHECKERS

A leading firm of Consultant-Contractors to the Oil and Chemical Industries is prepared to engage men in the following categories :—

Piping Designers	Salary range : £1200 to £1500 p.a.
Piping Draughtsmen	Salary range : £1100 to £1300 p.a.
Piping Checkers	Salary range : £1200 to £1400 p.a.
Structural Designers	Salary range : £1200 to £1500 p.a.
Structural Draughtsmen	Salary range : £1100 to £1300 p.a.

The positions are permanent and pensionable, and there are opportunities for promotion. Experienced men only are required. If you have experience in any of the above categories, write, giving details of previous career.—BOX No. E7779, "The Engineer." A

DEVELOPMENT ENGINEER required for a position of senior engineering responsibility in an integrated iron and steelworks where considerable development is to take place.

The successful candidate will be responsible for all new development and the co-ordination of planning and site work.

Applicants, who should be between 30 and 50 years of age, must be Corporate Members of the appropriate Institution of Civil, Electrical or Mechanical Engineers, and should be educated to Degree standard.

Engineering experience in steelworks or heavy plant manufacture is essential.

Application forms are available from :
The Labour Officer,
Richard Thomas & Baldwins, Limited,
P.O. Box No. 7,
Redbourn Works,
Scunthorpe, E7658 A

DIESEL ENGINEERS required by PERSIAN GULF OIL COMPANY. Minimum three years' experience on reciprocating and centrifugal pumps and diesel engines from 500 h.p. to 1000 h.p. Pay : 8s. per hour, 48-hour week guaranteed, plus free food, accommodation, medical attention, passages, &c.—Write to O.T.S., quoting reference 63/38, 5, Welldon Crescent, Harrow. E7875 A

DRAUGHTSMAN.—Arthur Guinness Son and Co. (Park Royal), Ltd., have a vacancy on their permanent staff for an Engineering Draughtsman. Applicants, aged 25/30 years, should have at least a National Certificate in Mechanical Engineering, together with works and drawing-office training. Experience in design and detail work in some of the following fields is essential : Chemical and Process Plants, Layouts and Services, Refrigeration Plant, Mechanical Handling and General Mechanical Engineering. The company provides a non-contributory pension scheme and excellent amenities. Commencing salary range is £700/£925, depending upon age and experience.—Applications, stating age, particulars of experience, &c., should be sent in confidence to the Personnel Manager, Arthur Guinness Son and Co. (Park Royal), Ltd., Park Royal Brewery, London, N.W.10. E7850 A

DRAUGHTSMEN required in the following categories : Senior and Junior Piping and Instrumentation ; Senior and Junior Reinforced Concrete ; Senior Mechanical, by engineers in City engaged on nuclear, petroleum, chemical plants. H.N.C./O.N.C. desirable. Salaries above average, five-day week, pension/life assurance and personal accident schemes, house purchase assistance, luncheon vouchers.—Write full particulars to Head Wrightson Processes, Ltd., 24/26, Baltic Street, E.C.1. E954 A

DRAUGHTSMEN required for General Engineering Works in Huddersfield district. Preferably accustomed to steelworks plant, but applicants with general experience considered. Good prospects and salary to suitable men. Superannuation scheme in operation. Please state full details of experience.—BOX No. E7873, "The Engineer." A

ENGINEERING GROUP requires REPRESENTATIVES, with good knowledge of mechanical engineering and casting design; vacancies for residents in or near North-East Coast, Yorkshire, Lancashire, London and the West Country. Good basic salary and car.—Reply, BOX A. 533, Central News, Ltd., 43, London Wall, E.C.2. E7823 A

Classified Advts. continued on page 6

SITUATIONS VACANT

ELECTRICAL DESIGNER sought by established manufacturers, in London, with world market for special-purpose precision machinery. Exceptional prospects for qualified electrical engineer having practical experience, aged 30-40, who is possessed of the "creative spark." Only applicant fertile in ideas, with original and inventive mind and receiving recognition in his present post on this account, need apply.—Write in confidence, Personnel Manager, Molins Machine Co., Ltd., Evelyn Street, London, S.E.8. E7882 A

ELECTRICAL ENGINEERING DRAUGHTSMAN required, with some experience in the preparation of schemes for M.V. electrical distribution and illumination and electrical equipment of industrial buildings. Minimum technical qualification O.N.C.

Minimum starting salary for draughtsmen of H.N.C. standard is £747 p.a. at 25. Salary reviewed annually. Conditions include a contributory pension scheme, assistance with house purchase, family education schemes, a wide variety of recreational facilities, &c.

Apply, stating age, qualifications and experience, to the Personnel Officer, PILKINGTON BROTHERS, LIMITED, Cowley Hill Works, St. Helens, Lancashire. E7881 A

ENGINEER required to visit engineering works in Great Britain to meet executives and give talks and demonstrations to production personnel. Considerable experience of production methods is required. Car provided and travelling expenses paid. Superannuation scheme in operation. Details of age, experience and qualifications, should be sent to BOX No. E7755, "The Engineer." A

ENGINEERING INSURANCE COMPANY invites applications from Engineers not over 35 years of age who possess First Class M.O.T. Certificate (Steam) for position as ENGINEER SURVEYOR in London and surrounding districts. Progressive salary scale rising to over £1000 per annum plus expenses and allowances. Non-contributory pension scheme and other staff schemes. Apply in own handwriting.—BOX No. E7903, "The Engineer." A

ENGINEER OR PHYSICIST at O.N.C. or H.N.C. level, to be responsible for material research and development in plastics and metals for laboratories in Camberley, West Surrey area. Canteen facilities. Contributory pension scheme.—Send particulars of age, qualifications and experience to Laboratory Supervisor, BOX No. E7814, "The Engineer." A

ENGINEER/SURVEYOR required immediately for medium-size road and sewer contracts in London area. Good prospects for young man.—Write in confidence, the Secretary, Fitzpatrick and Son (Contractors), Ltd., 455, Old Ford Road, Bow, London, E.3, stating age, experience, salary required, &c. E1129 A

ENGINEERS, with engine testing laboratory experience, are required for extensive programme of new product development. Starting salaries up to £850 p.a., according to previous experience. Ages betwen 23 and 33 are preferred, and H.N.C. Mechanical Engineering is a minimum requirement. Pension scheme.—Apply, in writing, giving age and full details of experience in chronological order, to Manager, Staff Department, F. Perkins, Limited, Peterborough. E946 A

ENGINEERS with specialised training in the design and execution of prestressed concrete projects are required for permanent employment in Rhodesia and the Union of South Africa. Free passages, pension scheme, excellent prospects.—Full details to BOX JY/29, c/o 95, Bishopsgate London, E.C.2. E973 A

EXPERIENCED CHIEF DRAUGHTSMAN required, for small mechanical and chemical engineering drawing-office of growing Anglo-American company in Camberley. Previous experience in drawing-office organisation essential, with sound grounding in mechanical engineering. Dynamic and enthusiastic approach to problems essential. Permanent and pensionable appointment.—Apply to GPB. Sharples Centrifuges, Limited, Tower Works, Doman Road, Camberley, Surrey. E7772 A

FORD MOTOR COMPANY, LIMITED, have a vacancy for an ELECTRICAL ENGINEER—A.M.I.E.E. or H.N.C.—to act as Personal Assistant to the Senior Electrical Engineer for the design and installation of electrical services. Applicants should have had a sound technical training and be well experienced in E.H.T. and L.T. substations, ring main cables, general distribution schemes, lighting, telephones, machine and plant wiring. They should also be capable of preparing specifications and estimates, supervising staff and negotiating with consultants and contractors.

Salary according to experience and ability, with participation in a generous non-contributory pension scheme.

Please write to Salaried Personnel Department, Ford Motor Company, Limited, Dagenham, Essex, stating age, experience and qualifications, and quoting reference EET. E7813 A

FOREMAN PLATELAYER required for laying new and maintaining existing railway track at large steel works in the Midlands. Staff position, pension scheme, free life assurance, &c. Write, giving details of age and experience.—BOX No. E7908, "The Engineer." A

INSTRUMENT ENGINEER.—Instrument men who have completed a trade apprenticeship, have subsequently had a minimum of five years' experience with a major user and/or manufacturer of process control instruments and who are technically qualified to Higher National Certificate standard in electrical or mechanical engineering, are invited to apply for the post of Assistant Instrument Engineer at the Newport factory of Monsanto Chemicals, Limited. A scheme of training for instrument mechanics has been set up at the factory and the successful candidate in addition to his other duties, will take an active part in its operation. Non-contributory pension scheme. —Applications in writing, stating age, experience and qualifications, to be addressed to the Personnel Manager, Monsanto Chemicals, Limited, Corporation Road, Newport, Mon. E7756 A

GRADUATE MECHANICAL ENGINEER

A Graduate Engineer is required by a progressive British company as Technical Assistant to a Senior Graduate Engineer at one of its modern processing factories. Many problems of a technical nature arise, and the successful applicant will take responsibility for handling these. The responsibility is clearly defined and initial training over many months will be given to prepare the new man for the position.

A good Degree in Mechanical Engineering and some basic workshop training is necessary. The company is prepared to delay the appointment should the right applicant not be immediately available. Age limit 28 years. This position is a starting point in the organisation and an excellent commencing salary will be paid to which will be added substantial increments in line with his progress and development.

In judging applicants the company will be looking at the man's development possibilities, both technical and administrative, as the company has a long record of healthy growth and wants its new men to be capable of growing with it. All factors such as superannuation scheme, &c., are available to suitable candidates, who should send, in confidence, a brief outline of their career to date.—BOX No. E7734, "The Engineer." A

Required for the establishment of a new
INDUCTION HEATING AND MECHANICAL HANDLING DIVISION
situated in the South Midlands,
Men with experience or interest in these fields, as :

PROJECT ENGINEERS—having Engineering Degree and/or professional qualifications, for electrical project design, specification and development work. Metallurgical and/or Production Engineering experience advantageous. Preferred ages 28–48. Salary : £1000–£1500 per annum, according to experience.

SENIOR TECHNICAL ASSISTANTS—having Engineering Degree or Higher National Certificate in Electrical or Mechanical Engineering, for general development work on engineering and metallurgical aspects of these fields. Workshop and development experience advantageous. Preferred ages 25–38. Salary : £900–£1100 per annum, according to experience.

JUNIOR TECHNICAL ASSISTANTS—having Ordinary National Certificate in Electrical Engineering or Advanced level G.C.E., for technical and development work. Workshop training an advantage.

Excellent opportunities in progressive and established Engineering Group, sports and canteen facilities. Superannuation.

Applications to Secretary.—BOX No. E1128, "The Engineer." A

INSTRUMENT ENGINEER required by The British Drug Houses, Ltd., to control small section in Engineering Department. Applicants must be capable of planning instrumentation of production plants and estimating, be experienced in maintenance, installation and design, and have H.N.C. Mech. Eng. or equivalent.—Write, stating age, qualifications, experience and salary required, to Staff Manager, Graham Street, City Road, N.1. E7872 A

JOHN LAING AND SON LTD.

are expanding their Mechanical and Electrical Design Department, which is engaged in a wide variety of work, including the design and development of Building and Civil Engineering Plant and Equipment ; the introduction of further mechanisation into construction processes, including materials handling equipment ; techniques for the production of a range of building components and the specification and design of machinery for their factory production.

Applications are invited for the following vacancies at the Research and Development Centre, Boreham Wood, Herts :—

SENIOR DESIGN ENGINEER (One required), to be responsible, under the Department Head, for the work of a group of Designers and Draughtsmen. Preferably A.M.I.Mech.E. with wide design experience in similar or allied fields. Age approximately 30–50.

DESIGN ENGINEERS (Two required), of Degree or H.N.C. standard or equivalent, and capable of undertaking design work.

ASSISTANT DESIGN ENGINEERS (Four required).

DESIGN DRAUGHTSMEN (Five required).

These posts are progressive and pensionable. The work is varied and interesting and holds attractive prospects in an expanding field. 5-day week, canteen and sports club facilities. Those interested should write for an application form to :—

Personnel Manager (S.D.B.7),
JOHN LAING AND SON LIMITED,
Page Street, London, N.W.7.
E7686 A

LARGE PUBLIC COMPANY requires, for new large subsidiary factory, first-class WORKS TECHNICIAN for the manufacture of universal motors suitable for portable tools and similar appliances. Must combine best works and technical design experience, able to evolve new motor types and be up-to-date with the latest modern mass production and factory management methods. Suitable candidate offered highly attractive contract, together with housing assistance and other long-term benefits. Present staff advised. Write fully, in confidence, to Technical Director, BOX No. E1115, "The Engineer." A

MANAGEMENT SELECTION LIMITED
have been retained to advise on the appointments of a

COMMERCIAL VEHICLE CHASSIS ENGINEER
and three
AUTOMOTIVE DESIGN ENGINEERS

for the Australian subsidiary of an American vehicle manufacturer. The company employs 4000 and is expanding : its modern manufacturing facilities are located in a temperate area near the sea. The company operates a pension scheme and can arrange housing.

The Commercial Vehicle Chassis Engineer (Reference G.481) will be responsible for the chassis design of an Australian range of trucks up to 7 tons capacity currently based on imported major assemblies, but requiring the design of components for local manufacture in addition to application engineering. The proportion of the vehicles manufactured locally is already 70 per cent and this is increasing. Candidates must have a Degree or professional qualification in Mechanical Engineering ; experience of commercial vehicle design including heavy vehicles, knowledge of proprietory components used in truck manufacture ; and have led a design team. Preferred age 32–45. Initial salary £A1500–£A2400, according to experience.

The Automotive Design Engineers (Reference G.543) will handle a wide range of design problems, including basic layout and stress analysis. Candidates should have a Degree or professional qualification in Mechanical Engineering and experience of passenger or commercial vehicle design. Preferred age 28–40. Salary £A1200–£A2000, according to experience.

Please send brief details in confidence, quoting appropriate reference, to T. E. Watson, Management Selection Limited, 17, Stratton Street, London, W.1. No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. E7832 A

MECHANICAL ENGINEER

Markham and Co., Ltd., have a vacancy for a suitably qualified Mechanical Engineer as an Assistant to the Experimental Engineer at their works in Chesterfield. Applicants should have a knowledge of vibration analysis as applied to the Heavy Engineering Industry. Previous experience in experimental work on projects of original design is essential.

Applicants should give age, concise details of education and past experience, duties and degree of responsibilities.—Applications should be addressed to the Secretary, Broad Oaks Works, Chesterfield. E7795 A

MECHANICAL ENGINEER required for Mining Company in WEST AFRICA as Assistant to Mechanical Superintendent. Age approximately 30/35, preferably with experience of planned maintenance of opencast Mining and Conveying Equipment, Work Study and General Workshop practice. Commencing salary £1200 per annum, but more would be paid for exceptional experience. Tours of duty approximately 15 months, followed by liberal leave on full salary in U.K. Return passage paid. Free furnished quarters and medical attention. Marriage and children allowances. Contributory pension and life assurance and dependents income schemes.—Write, giving full particulars, to Sierra Leone Development Co., Ltd., Dept. E6, City-Gate House, Finsbury Square, E.C.2. E7843 A

MECHANICAL ENGINEER required by Smiths Motor Accessories, Ltd. H.N.C. standard, and at least 5 years' practical experience in light engineering, preferably instrument testing.—Apply to Mr. D. H. Squire, Cricklewood Works, N.W.2 (GLA 3333). E7858 A

MECHANICAL ENGINEERING DESIGNER

Consulting engineers require a competent mechanical engineering designer in their product design division. It is planned to expand this division considerably and it is in mind that the successful applicant should merit promotion to Chief Designer responsible to the Board within a few months.

The qualifications required are a sound technical engineering background with a university Degree in Engineering and membership of the Institution of Mechanical Engineers. Whilst some years of design experience are desirable this is less important than technical ability and qualities of personal initiative. Age limits 30-40 years.

The company acts mainly as consulting engineers to the engineering industry and this is an opportunity for a relatively young man of ability to take part in the building up of a design consulting practice in association with production engineers and other industrial specialists. The nature of the work is extremely varied but staff are encouraged to develop their special aptitudes when opportunity occurs.

Non-contributory life insurance and pension schemes are in operation and a minimum salary of £1500 per annum is offered.

Please write full particulars in strict confidence. —BOX No. E1090, "The Engineer." A

REQUIRED FOR THE CENTRAL RAILWAY OF PERU, LTD., ASSISTANT ELECTRICAL ENGINEER (diesel), to have served an electrical engineering apprenticeship and be a Graduate of the Institution of Electrical Engineers. Must have had practical railway experience in the maintenance and repair of diesel/electrical locomotives. Must be physically fit to carry out inspection trips and work periods at altitudes of 15,000ft. Age 23–30 years. Salary offered £1300 per annum plus cost-of-living allowance of approximately 20 per cent.—Please apply in writing to Peruvian Transport Purchasing Co., Ltd., Rex House, 38, King William Street, London, E.C.4. E7825 A

PETER LIND & CO., LTD., Romney House, Tufton Street, Westminster, S.W.1, have vacancies for fully qualified SITE ENGINEERS for civil engineering contracts.—Apply in writing only, stating age, experience and salary required. E7887 A

PILKINGTON BROTHERS, LIMITED, invite applications for a position in the estimating section of a medium-sized drawing-office. The work covered by this section includes :—

1. The preparation of approximate estimates for buildings and plant from brief specifications and/or arrangement drawings.
2. Preparation of estimates for capital sanction from final arrangement and detail drawings. This work requires an intimate knowledge of the mechanical engineering trades and practices.
3. Valuation of plant and buildings for asset verification and fire insurance purposes.

Applicants should have some experience in one or more of these fields and should be qualified to O.N.C. standard.

Minimum starting salary for applicants having suitable experience and qualifications is £721 p.a. at 25.

The company operates a contributory pension scheme, assists with house purchase and has excellent canteen, welfare and recreation facilities.

Applications, giving brief details of career, should be sent to the Chief Engineer, Pilkington Brothers, Limited, Cowley Hill Works, St. Helens. E7883 A

PLANT ENGINEER FOR COKE OVENS required on an integrated iron and steel works, where large extensions of Coke Producing Plant are to be built.

Applicants should be educated to at least H.N.C. standard and must have served a recognised apprenticeship in mechanical engineering.

Candidates should be preferably between 30–50 years of age.

Application forms are available from :
The Labour Officer,
Richard Thomas and Baldwins, Limited,
Redbourn Works,
Scunthorpe, Lincs. E7657 A

RESEARCH ENGINEER required for high-speed diesel engine research. Applicants must have experience of internal combustion engine laboratory work, and also direct knowledge of latest fuel injection methods and combustion chamber products. Preference will be given to applicants who are aged between 27 and 35, and A.M.I.Mech.E. The work is varied and interesting. Pension scheme. — Applicants should write, giving age and full details of experience in chronological order, to the Manager, Staff Department, F. Perkins, Limited, Peterborough. E947 A

RESIDENT ENGINEER AND INSPECTOR OF WORKS urgently required for important factory extensions in Doncaster area, involving steel-framed and reinforced concrete construction and general building works. Applicants for the post of Resident Engineer must be Corporate Members of the Institution of Structural or Civil Engineers and have held a responsible position on site works of this nature. Applicants for the post of Inspector must have had previous sound, practical experience of general building works. Emoluments will be fixed according to qualifications and experience.—Applicants are invited to write in confidence to Scott and Wilson, Kirkpatrick and Partners, Consulting Civil and Structural Engineers, 47, Victoria Street, Westminster, S.W.1, stating age, professional qualifications and full details of experience to date, together with the names of two referees. E7869 A

SALES ENGINEER required for the London office of a leading firm of pump and compressor manufacturers. Applicants should have a sound knowledge of pumps and/or compressors and their application, and should be used to estimating. Good salary and prospects for suitable applicant. Apply in confidence, stating age and experience.—BOX No. E1089, "The Engineer." A

SENIOR ASSISTANT ENGINEER required for the development of specialised electrical transmission equipment involving heavy currents, together with the design and execution of contracts for work of this nature. Candidates should be qualified to Degree standard or equivalent in either Mechanical or Electrical Engineering and should preferably have experience in some form of power transmission engineering. A person in the age range 30 to 40 would be preferred. Five-day week. Pension fund.—Applications in writing to Personnel Officer, British Insulated Callender's Cables, Limited, Surrey House, Temple Place, London, W.C.2, reference L.13. E7821 A

SENIOR DESIGNERS required for mechanical handling machinery as applied to brewery industry. Salary according to ability, but not less than £900 p.a., with prospects. Pension scheme, canteen, five-day week.—Apply to Chief Draughtsman, G. Hopkins and Sons, Ltd., United House, North Road, London, N.7. E7742 A

SENIOR DRAUGHTSMAN required for steel works in the Midlands area. Experience in steel works practice desirable but not essential. Good conditions and prospects and permanent situation offered to suitable applicant. Pension scheme and free life assurance scheme and canteen facilities. Excellent salary range. Apply, giving age and experience.—BOX No. E7907, "The Engineer." A

SENIOR ELECTRICAL ENGINEER required for interesting and varied work. A.M.I.E.E. and/or Graduate, with experience in modern power distribution, rotating and static equipment, electronics, instrumentation, design of automatic controls, modern heating techniques, &c. Age 30 to 40 with knowledge and experience of modern labour control and administration. Salary commensurate with qualifications and experience.—Apply in writing to the Personnel Manager, Ferodo Limited, Chapel-en-le-Frith, Via Stockport. E7713 A

STEEL WORKS ASSISTANT ENGINEER required by a large Midlands steel works to supervise the maintenance of a modern open-hearth melting shop and associated waste heat boiler installation. Applicants should be of Higher National Certificate standard or equivalent and have experience of modern steel works maintenance. This is a staff position with a pension scheme and free life assurance. Write, giving full details of age, experience and remunerations required.—BOX No. E7909, "The Engineer."

SITUATIONS VACANT

SMITHS MOTOR ACCESSORIES, LTD., require

SENIOR DESIGN DRAUGHTSMAN with experience of instruments or light engineering. Minimum qualifications 3 years' design experience, O.N.C. standard. Monthly status for right man.

SENIOR DRAUGHTSMAN for Production Drawing-Office, with experience of instruments or small mechanisms, at least O.N.C. standard. Knowledge of press work an advantage.

QUALITY CONTROL ASSISTANT ENGINEER, O.N.C. (Mech.). Experience of instruments or small mechanisms. To ascertain causes of developed faults.

WORK STUDY ENGINEERS, fully qualified.

PLANT LAYOUT DRAUGHTSMAN, O.N.C. or equivalent, with experience of minor building alterations. Layout of machine tools.

METHODS ENGINEER, sound mechanical background, with some knowledge of assembly procedure and layout.

Apply to Mr. D. H. Squire, Cricklewood Works, N.W.2 (GLA 3333). E7859 A

TECHNICAL ASSISTANT, with steam raising and general engineering services and some building experience, H.N.C. standard, required for Engineers' Dept., The London Hospital, Whitechapel, E.1. Salary scale £600–£750 p.a., and London weighting. —Applications to be made to the Chief Engineer. E7911 A

TECHNICAL SALES MANAGER required by Birmingham company, Hall Green area, operating a highly advanced, fully automatic metal and plastic mouldings process with nation-wide application. The post offers unusual scope to a man of initiative and involves the preparation of estimates and quotations. Previous experience in the metal and plastic mouldings field would be helpful, but is not essential. Applications, which will be treated in confidence, should state age, present and previous positions held, and salary required.—BOX No. E1131, "The Engineer."

THE HARLAND ENGINEERING CO., LTD., Alloa, has a vacancy for a PROCESS PLANNING ENGINEER. An experienced man is desired, but suitable applicants willing to be trained will be considered. A sound knowledge of modern machine shop practice essential and a knowledge of fabrication assembly and jig and tool design is desirable. Staff appointment with superannuation scheme.—Applications, with full particulars of age, experience and technical training, &c., to Personnel Manager. E7849 A

THE NESTLE CO., LTD., require a MACHINE TOOL ENGINEER, to be responsible for tinshop quality control, tool and precision machine maintenance in their Northern Irish manufacturing centres. All applicants must have had practical experience and served an approved apprenticeship. Prior tinshop experience an advantage, but not essential, as a familiarisation period on this type of plant can be arranged. Age limit 30–35. The post carries staff status and salary would be according to experience. Excellent pension scheme and housing provided.—Applications to The Nestle Co., Ltd. Production Division, Hayes, Middlesex (ref. IHC). E7722 A

THE NESTLE CO., LTD., require a qualified and experienced MECHANICAL ENGINEER for their new factory to be erected near Carlisle, Cumberland. The successful candidate would also assist in the planning stages and supervise the erection of this factory. Prior experience on process plant, boiler plant and refrigeration essential. Age limit 33/38. Salary according to experience, excellent pension scheme and housing provided.—Applications to The Nestle Co., Ltd., Production Division, Hayes, Middlesex (ref. IHC). E7701 A

THE SUPERHEATER COMPANY LIMITED,
53, HAYMARKET, LONDON, S.W.1.

SENIOR AND JUNIOR DRAUGHTSMEN required for Power Plant Division at their London Office. Experience in steam boiler plant an advantage but not essential. Permanent and pensionable positions offering good prospects for suitable applicants.—Applications are invited to the Secretary, giving full details of qualifications and experience. E7865 A

TWO DEPUTY RESIDENT ENGINEERS AND ONE ASSISTANT RESIDENT ENGINEER are required for the supervisory staff on a very large and important building project in Central London, involving heavy foundation works and reinforced concrete and steel-framed structures. Candidates for the Deputy Resident Engineers' appointments must be Corporate Members of the Institution of Civil or Structural Engineers and have had at least ten years' practical experience in works of this nature. Candidates for the Assistant Resident Engineer appointment should preferably be Members as aforesaid or hold a University Degree in Civil Engineering or equivalent and have had some site experience. Work on this project will be continuous and the successful candidates must be prepared to take day or night duty on a rota basis.—Applicants are invited to write in confidence to Scott and Wilson, Kirkpatrick and Partners, Consulting Civil and Structural Engineers, 47, Victoria Street, Westminster, S.W.1, stating age, professional qualifications and full details of experience, to date, together with the names of two referees. E7868 A

WORKS MANAGER, to take complete control of manufacture of medium-sized electrical rotating equipment. Applicants (30/45) should be well versed with modern manufacturing processes, have drive, enthusiasm and preferably experience in manufacture of electrical apparatus. Write in confidence, giving full details of experience, salary required and age.—BOX No. E1127, "The Engineer." A

VACANCIES EXIST FOR

PHYSICISTS, ENGINEERS and CHEMISTS

with Degrees or equivalent qualifications, in the Industrial and Domestic Division of the British Coal Utilisation Research Association for urgent projects relating to gasification, pyrolysis reactions, specialised instrument mechanisms, the design of grate and feed mechanisms, &c. Applicants, who should possess general adaptability, will be encouraged to publish the results of their work, and are given every opportunity of meeting the technical representatives of the industries concerned.

Salaries according to qualifications and experience, but in the range £700–£1000 for younger men.

Five-day week, superannuation and grading schemes.—Apply in writing to Assistant Secretary, ref. "I.D.," B.C.U.R.A., Randalls Road, Leatherhead, Surrey. E7826 A

BOOKS and PUBLICATIONS

PITMAN TECHNICAL BOOKS

Parker St., Kingsway, London, W.C.2.

THE CALCULATION OF SHEET METAL WORK

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with operational experience on large modern power stations are required for new careers as Commissioning Engineers on nuclear power station projects.

Men, preferably between 25-40 years of age with professional engineering qualifications, are invited to write, giving full details of their education, training, experience and present salary, to C.P.S., Marconi House, 336/7, Strand, London, W.C.2. quoting reference E 1817W. E7812 A

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HOUSING.—After joining the staff married men will receive a reasonable refund of removal (including travel) expenses and, to assist them in house purchase, facilities are available in approved cases for substantial loans. In addition, legal charges will be advanced. A lodging allowance will be paid for a period to married men selected for these appointments whilst maintaining two homes.

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Classified Advts. continued on page 8

SITUATIONS VACANT

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are required for interesting new car projects in an expanding engineering programme.

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Research and Development Engineers are required to join an expanding team now at work in John Thompson's new research centre at Wolverhampton, serving some twenty-three companies of the Group. Men with a Degree in Mechanical Engineering or Physics or Higher National Certificate are wanted for interesting and varied work on General Mechanical Engineering problems, particularly stress analysis and heat transfer. They should be capable of carrying out complete projects from the design of the test apparatus to the writing of the final report.

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JOHN THOMPSON LIMITED,
WOLVERHAMPTON. E7851 A

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This Company, situated on the Dorset Coast, invites applications for interesting and progressive positions as listed, at their various establishments in Poole. The products are Pumps (Centrifugal and Positive Displacement), Compressors, Oil Burning Equipment and Hydraulic Pumps and Control Valves. In the last five years, turnover has increased fourfold and due to a continued increase in the Company's sales, a further considerable expansion is being planned. Employees now number about 650 and may be expected to increase to about 1000 in three years.

The Company's policy is to promote from within, hence applications will be surveyed with the view to further ultimate promotion after proven ability.

The conditions of employment are amenable, with canteen and pension scheme facilities, &c.

Applicants please apply in writing at once to Personnel Officer, New Quay Road, Poole, quoting ref. and stating full details of age, training, qualifications, experience, marital status, availability and ultimate position aimed at. Absolute confidence is guaranteed.

Ref. 1 : **WORKS MANAGER**—Hydraulics Division.
Age 35–45. Must be fully qualified and experienced in Precision Production, including Methods, Jig and Tool Design, Production Control, &c. It is essential that drive, energy and tact are also possessed for this important and developing appointment, as well as the ability to plan further expansion.

Ref.2 : **PRODUCTION SUPERINTENDENT**—Hydraulics Division.
Age 35–40. Essentially a time-served apprenticeship and experienced in precision production ; to control machine and assembly shops. Only those now holding similar positions should apply.

Ref. 3 : **METHODS ENGINEER**—Hydraulics Division.
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Ref. 4 : **TEST ENGINEER.**
Must be qualified H.N.C., methodical and critical in his approach to high technical performance. Some electrical background desirable, but basically fluid dynamics for hydraulics engineering. The candidate sought is one of broad test experience who may later be involved in testing large pumps, compressors and oil-burning equipment.

Ref. 5 : **INSPECTORS.**
Practical men with machine shop experience and extensive previous Inspection duties ; vacancies exist in all departments of the Company.

Ref. 6 : **SUPERVISORS.**
Setters and Charge hands for machine shop and assembly. Only those with proven supervisory experience will be considered and these posts involve shift work. Age preferable 30–35.

Ref. 7 : **DESIGNERS.**
The Company seeks men of H.N.C. and/or Degree qualification, preferably with experience in Pumps and Compressors or suitable experience for the other products involved.

Ref. 8 : **DESIGN DRAUGHTSMEN AND DRAUGHTSMEN.**
Requirements in the various age groups for interesting work in pumps (centrifugal and positive displacement), compressors, oil burning and hydraulics. O.N.C. and/or H.N.C. desirable.

Ref. 9 : **JIG AND TOOL DRAUGHTSMEN.**
With adequate experience of either precision production or tooling for batch work (press tool experience unnecessary). Must be able to develop tool design from method layouts. Age 25–40. Preferably O.N.C.

Ref. 10 : **TECHNICAL SALES ESTIMATORS.**
Age 25–30. Although previous similar experience is desirable, it is not essential, but the requirement is for ex-Drawing-Office personnel with ability to develop in tendering and customer contact. The Company normally draws its Sales Engineers from this source.

Ref. 11 : **CONTRACTS ENGINEERS.**
Age 25–35. Essentially qualified and methodical administrators, preferably with site experience. Sound engineering training essential, but yet with commercial acumen.
E7719 A

SITUATIONS VACANT

HARDY SPICER LIMITED

a member of the BIRFIELD Group of Companies

intends to develop its Product Engineering Department, whose function covers product specification and design and technical service to customers. In consequence a number of vacancies exist as follows.

1. TECHNICAL ASSISTANT. Responsibilities will include providing technical advice and service to customers, calculating specifications relating to product design, applications, and improvements, and the supervision of a group of design and development draughtsmen. Requirements are an education standard of B.Sc. or A.M.I.Mech.E., an apprenticeship followed by experience in design and technical departments. An enthusiasm for mathematics is desired and experience of bearing design would be welcome. Age range approx. 26–40.

2. CHIEF DRAUGHTSMAN. This position will involve the organisation and control of drawing sections and other drawing-office services, including the supervision of the handling of orders and enquiries from customers. Technical education to A.M.I.Mech.E. level is required, as is experience of a responsible drawing-office position, such as Assistant Chief Draughtsman. Age range 26–40.

3. DESIGN DRAUGHTSMEN. Designers are needed to undertake work on product design and improvement under the Technical Assistant. Applications for these vacancies should have H.N.C. in Engineering, and drawing-office experience which included some design work. Ability to produce ideas and to work on own initiative are important. Age range 26–35 approx.

4. DRAUGHTSMEN. There is opportunity in this reorganisation for one or two Draughtsmen to join this department and set out on a career in which, for the able man, opportunities will not be lacking. Men with H.N.C. or working for it, and with drawing-office training, are invited to apply.

These appointments will involve working at Witton initially with transfer to the Company's new premises at Chester Road, Erdington, when the new office accommodation is ready.

In all cases, the salary and other conditions of service will be attractive.

Applicants are invited to write, stating in which of the above they are interested, and giving particulars of age, education, training and experience, to the Personnel Director, Hardy Spicer, Ltd., Birch Road, Witton, Birmingham, 6. E7854 A

A.E.I. — JOHN THOMPSON NUCLEAR ENERGY COMPANY LIMITED.

MECHANICAL ENGINEER

to work on the design and development of mechanisms associated with nuclear power stations.

The work provides scope for original thought on varied equipment essentially of a novel nature. Applicants will be required to handle schemes, varying from light to medium engineering, through design and development stages up to commissioning.

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The company's new design offices provide excellent working conditions and high-class dining and travel facilities are available. The company operates a contributory pension scheme.

Please reply in writing to the Chief Engineer, Radbroke Hall, Knutsford, quoting Reference MED/S. E7716 A

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The Billingham Division of Imperial Chemical Industries, Limited, has a vacancy for a Road Transport Maintenance Engineer, who will be responsible for the maintenance of a large mixed fleet of road vehicles and factory mobile machines such as tankers, lorries, cars, vans, bulldozers, cranes and fork lift trucks.

Applicants should possess a University Degree or its equivalent in Mechanical or Automobile Engineering, and must be conversant with road transport problems, including planned maintenance, engine testing and costing. Management experience is essential.

The post offers excellent opportunities for promotion.

The Company operates a pension fund and profit sharing scheme ; it gives assistance towards house purchase and makes grants towards removal expenses for married men.

If you are interested and between 26 and 38 years of age, please write for an application form to the Staff Manager, Imperial Chemical Industries, Limited, Billingham Division, Billingham, Co. Durham, quoting reference W/V/1. E7853 A

SITUATIONS VACANT

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A Group of Companies operating in the contracting, structural steelwork and light engineering fields proposes to appoint a DIRECTOR to the subsidiary company concerned with its manufacturing activities. The appointment follows some redistribution of work between the component companies of the group, and the factory to which the appointment will be made, which is in the London area, is concerned with the manufacture of hydraulically actuated tools and equipment and steel fabrication.

The man appointed must be capable of co-ordinating and developing existing sales, in conjunction with his Sales Director, Works Management, including costing and initiating such organisation changes as may be needed. The prospects, which are excellent, are reflected in the proposed salary arrangements. A starting salary of £2500 p.a. might be anticipated by a man who can show evidence of success in the field of general management.

Please reply, giving full details of experience and appointments held, to BOX No. E1118, "The Engineer."

Applications will be dealt with in the strictest confidence. A

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E7855 A

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Classified Advts. continued on page 10

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Tel.: Pudsey 2241. E204 G

VALES PLANT REGISTER LIMITED

OFFER FOR IMMEDIATE SALE
CRANES

Two Jones " Super 40 " 3-ton Diesel Mobile Cranes, 24/30ft. jibs, on solids. Overhauled and in excellent condition. £1150 each o.n.o. On pneumatics, £1300 each o.n.o.
One Jones 4-ton KL44 Diesel Mobile Crane. New 1948. With 24/40ft. jib. Thoroughly reconditioned.
One 5-ton Smith Diesel-driven Mobile Crane, type 45 Super, powered by Dorman diesel engine, with 32ft. 6in. jib, on twin pneumatics, with steel cab. New 1949. Overhauled and in excellent condition
One Butters 5-ton Steam Derrick Crane, 100ft. jib Recently overhauled
One Butters 7-ton Electric Derrick Crane, 100ft. jib. In good condition.
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One Ransomes Rapier 8½-ton Super Mobile Electric Crane. Standard cantilever jib. In very good condition.
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BLISS 3½B DOUBLE-ACTION TOGGLE PRESS, punch stroke 12in., distance between slides 26in., 400/3/50.
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NEW BENTLEY 30 TONS INCLINABLE POWER PRESS, adjustable stroke, 400/3/50.
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PLATT 20-TON 0/F, GEARED INCLINABLE POWER PRESS, 3in. stroke, 400/3/50.
Ask for our latest Stock List.

THOS. W. WARD LTD.

ALBION WORKS - - - SHEFFIELD,
'Phone : 26311. 'Grams : " Forward." E213 G

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VENTILATING FANS

New Porthole type Propeller Fans, 4-blade pattern, 12in. to 36in., for prompt delivery, with either 230/250 volts, single phase, motors, or 400/440 volts, 3-phase, motors. Industrial, totally enclosed and flameproof types available.

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WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070 ; and STANNINGLEY, NR. LEEDS.
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RECONDITIONED MACHINERY FOR SALE

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in. 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic, 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.
AIR COMPRESSORS.—Broomwade 510 cu. ft.; Tilghman 365 cu. ft.; Broomwade 300, 200 and 130 cu. ft.; all motorised.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.
CRANES.—8¼-ton Ransomes Diesel Electric, 1952 ; 6-ton Coles Diesel-Electric, 1948 ; 4-ton Jones KL44 Mobile Diesel; 4-ton Coles Diesel-Electric ; 3-ton Jones Diesel " Super 40 " (3) ; Neals 2-ton Diesel, 20ft. jibs (10) ; 5-ton Butters, 90ft. jib ; 5-ton Wilson, 70ft. jib, all 400/3/50 ; Steam Loco Type, 8-ton Wilson, 35ft. jib ; 5-ton Smith, 50ft. jib (2) ; 5-ton Cowans Sheldon, 50ft. jib, 1940 ; E.O.T., 40-ton Butterley, 42ft. 3in. span ; 20-ton Clyde " Goliath," 40ft. track ; 5-ton Clyde, 34ft. span ; 2-ton Smith, 34ft. span (4).
RAILWAY MATERIAL.—Peckett 14in. by 22in. and 7in. by 12in. Steam Locos.; 3 miles 20 lb. Track, 24in. gauge bogies, turnouts, locos., &c.
STEEL PIPING.—10,000ft., 2in.; 5000ft., 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 280ft., 21in. o.d. welded flanged ; 380ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft., 60in. riveted.
CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.
VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.
STORAGE TANKS.—300, cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

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COLEFORD, GLOS.
'Phone : Coleford 2271/2. E366 G

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CONDENSING STEAM TURBO-ALTERNATOR SETS

3000kW., 6600/3/50 MET-VICK, Pass-Out Set, date 1948, designed for 340 p.s.i.g. initially, 600 deg. F. temp., also suitable for the following duties :—

Output, kW	Pass-out/ lb/hour	Lb pressure
3000	60,000	40
1800	40,000	110
1800	40,000 double p/out at	110 and 40

1000kW fully condensing.
1000kW., 3300/3/50, Condensing or Mixed-Pressure Set, BELLISS and MORCOM, turbine for 125 p.s.i.g., coupled through gearbox to Mather and Platt alternator, complete with jet condenser by Belliss, with ancillary plant and switchgear.

GEORGE COHEN,

SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070 ; and STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E203 G

FOR SALE

2-ton Jones Super 22 Diesel-driven Mobile Crane on pneumatics with 24ft. jib.
3-ton Jones Super 40 Diesel-driven Mobile Crane on pneumatics with 30ft. jib.
5-ton Smith Steam Crane, new 1949, with 35ft. jib.
5-ton Morris Versatile Diesel/Elec. Mobile Crane on solids.
6-ton Ransomes and Rapier Standard Diesel/Elec. Mobile Crane on solids.
6-ton Ransomes & Rapier Super Petrol or Diesel/Elec. Mobile Crane on solid rubber tyres.
Priestman " Wolf " with skimmer and back acter equipments.
Ransomes and Rapier 440 Excavator, with face shovel and dragline equipments.
Ransomes and Rapier 462 Excavator, with crowd shovel equipment. New 1952.

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Tel.: 639081 (10 lines).

SEARCH (LIVERPOOL), LIMITED, HAMMOND ROAD, KIRKBY TRADING ESTATE, LIVERPOOL.
Tel.: Simonswood 2634–5–6.
E7724 G

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FOR SALE

Designed for 190-ton on 58ft. span, 72ft. lift, by Sir Wm. Arrol and Co., Ltd., now arranged for 106ft. span, capacity 90 tons. Can be altered to any intermediate span with equivalent lifting capacity. Weight 334 tons.

REED BROTHERS (ENGINEERING), LTD., Replant Works, Woolwich Industrial Estate, London, S.E.18.
Tel.: Woolwich 7611/6. E971 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts ; also " Romney " Huts, 35ft. wide, and " Blister " Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel., Bexleyheath 305). E681 G

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LATE TYPE
GEAR MAKING MACHINES
IN STOCK

SHAPERS

LORENZ Model SV00 (Fellows type), motor drive, for internal and external spur and helical gears. External gears : max. spur dia. 7½in., max. helical dia. 6½in., max. face width 2in.; internal gears : max. spur dia. 5½in., max. helical dia. 5½in., max. face width 1 ¼in., max. D.P. for spur gears in steel 6·35, 6 speeds, 164–535 strokes/min.
FELLOWS No. 71, motor drive, for external and internal spur gears only, max. ext./int. pitch dia. 7in./5½in., max. ext. face width 1½in., max. int. face width ¾in.-1in., max. ext. D.P. 6, max. int. D.P. 6/8, max. cutter dia. 3in.
DRUMMOND " MAXCIUT " No. 3 for internal and external spur gears only. Max. int. and ext. pitch dia. 18in., max. ext. face width 5in.; max. int. face width 3in., max. spur D.P. 3/4, 8 speeds, 50–300 strokes/min.

PLANERS

BILGRAM 6in. Straight Bevel Gear Planer, motor drive, single tool type, max. pitch dia. 7¼in. (ratio 1 : 2), range of pitch angular adjustments 9 deg. to 85 deg., largest apex distance 7¼in., longest face 3in., coarsest pitch 3½ D.P.
SUNDERLAND 5A, motor drive, for spur and spiral gears, max. dia. 12in., max. face width 4in., max. D.P. 5, max. spiral gear combination 60 deg., ¾in. normal pitch, 2¾in. face width, max. distance spindle end to outer supports 16½in.
SUNDERLAND 5C, for spur gears only, capacity : max. dia. 24in., max. face width 5in., max. D.P. 4, max. distance spindle end to outer support 16½in.

HOBBERS

PFAUTER R.2, motor drive through 6-speed gearbox, with differential, max. gear dia. 39¾in., max. face width 11¾in., max. D.P. 2¾.
GOULD & ERBERHARDT Model 8H Gear Hobber, motor drive, for spurs, splines, sprockets and worm wheels, max. dia. 6in., table dia. 10in., face capacity spur gears 12in., 4 D.P., 10 hob speeds 48–200 r.p.m.
PFAUTER R9 Horizontal, motor drive, for small dia. spur gears with coarse teeth, heavy splined shafts and worms, height of centres 5 ⅛in., max. dia. hobbed 10¾in., max. hobbing length 19¾in., max. D.P. 2, min./max. No. of teeth hobbed 4–100, 6 hob speeds, 44–127 r.p.m.
MUIR Model M.T.9 Heavy Duty Large Capacity Hobber, for spur, spiral and helical gears and worm wheels, max. dia. of spur gears and worm wheels 90in., max. dia. of spur gears running at high speeds 72in., max. spiral dia. with max. width at 10 deg. angle 90in., max. spiral dia. with max. width at 45 deg. angle 70in., max. spur and helical width 26in.–30in., according to dia., max. D.P. 1¼, table dia. 58in., range of hob speeds 18–80 r.p.m., h.p. main motor 12.

GEAR GENERATOR

RAPIDAN Heavy Duty Gear Generator, Size No. 4 extended, motor drive, for internal and external spur gears, capacity : internal gears 68in. dia., external gears 56in. dia., face width 1in.–6in. max. max. D.P. 2.
Full details from :—

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'Phone : RELiance 7201.
'Grams : Sotoolsag, London, S.E.11. E210 G

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(FOR PROMPT DESPATCH)

Quantity of 24kW. and 15kW. Compound Wound, 100-volt D.C. Generators, by L.D.C., E.C.C., and E.E.C., drip-proof frames with endshield ball/roller bearings, various speeds between 1440 and 1625 r.p.m.
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VAN NORMAN INTERNAL AND EXTERNAL OSCILLATING GRINDERS for raceway and other spherical work up to 16in. diameter.

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359, EUSTON ROAD, LONDON, N.W.1.
EUSton 4681. E7633 G

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FOR SALE

Nearly new 100-ton Electric Overhead Travelling Crane, 100ft. span. Span can be reduced down to 58ft., at which the lifting capacity is 190 tons. Electrics 400 volts, 3 phase, 50 cycles, 72ft. lift.

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FOR SALE

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DIESEL ALTERNATOR SETS

Quantity 30kVA. GARDNER/MAWDSLEY self-contained Sets, engine vert., 4 cyl., 4LW radiator cooled, electric start, 1000 r.p.m., alternator 400/3/50.
Five 5·625kVA. LISTER/E.C.C. Sets, engine vert., single cyl., 9/1/35, 4 stroke, hand start, 1000 r.p.m., alternator 230/1/50.
Three Unused 5·625kVA. RUSTON/E.C.C. Sets, engine vert., twin cyl., 2VTH radiator cooled, 4 stroke, hand start, 1000 r.p.m., alternator 230/1/50.

GEORGE COHEN,

SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070 ; and STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E200 G

B.C.S.

15,000 Babcock and Wilcox C.T.M. type Water Tube, 180 lb., with superheater, economiser by Green. All mountings.

3, CASTLE STREET, CARDIFF.
Tel.: Cardiff 29246. E7878 G

FOR SALE

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Heenan and Froude 2000 h.p. Dynamometer : £250.
2in./1¼in. Pulsometer Centrifugal Pumps, 40 g.p.m., 50ft. head. 50 unused. £18 each.
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DEPTEX
1 COMPTON ROAD, COLCHESTER
E1122 G

B.C.S.

One 1500kW. Brush-Ljungstrom Turbo Alternator Set, 6600 volts, 3 phase, 50 cycles, 0·8 P.F., W.P. 200 p.s.i., complete with auxiliaries.
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3, CASTLE STREET, CARDIFF.
Tel.: Cardiff 29246. E7876 G

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STEAM LOCOMOTIVES.—Two Hudswell Clarke Standard Gauge, 15in. by 22in. cylinders, boiler pressure 180 lb.—For further particulars apply to Appleby-Frodingham Steel Company (Reference P/B), Scunthorpe, Lincs. E7840 G

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ALBION WORKS, SHEFFIELD

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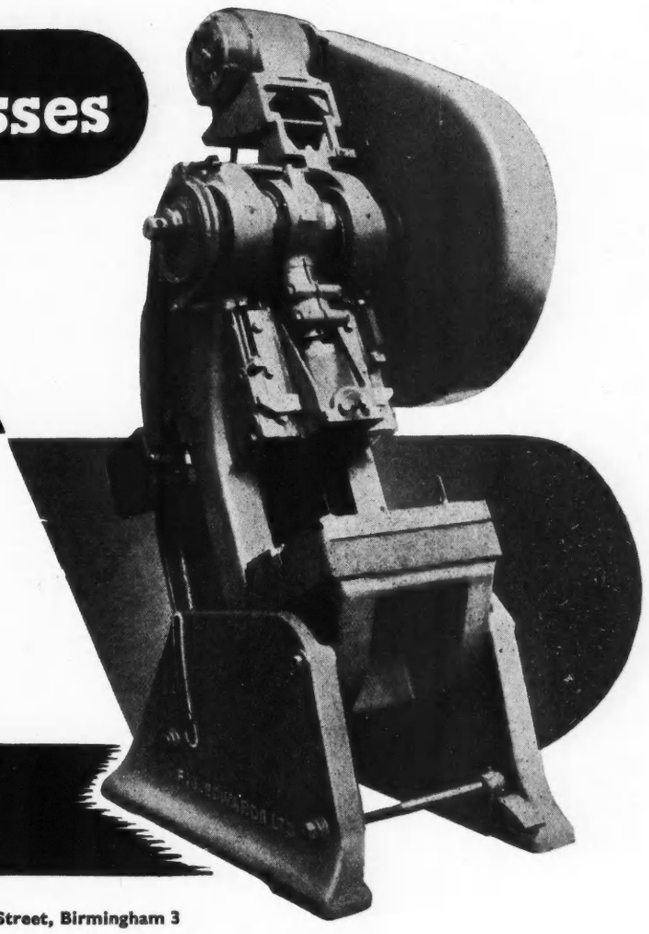
THE BESCO

Inclinable Power Presses

Model BA, Mark II.

bring pressure to bear with power to spare



These machines have all the qualities making them the key to your press shop and they can be supplied IMMEDIATELY FROM STOCK or just when you want them.

First, and essentially, they will give you quality in workmanship and accuracy in their operation.

From the foremost medium range on the market, Besco Inclinable Presses, Model BA, Mark II, sizes 19, 20 and 21. (Registered Design No. 841913.)

Size	Pressure Exerted	Adjustable stroke
BA19	10 tons	⅜in.—2⅜in.
BA20	28 tons	⅜in.—2⅜in.
BA21	40 tons	⅜in.—3½in.

They give you top capacity with plenty of safety and the adjustable strokes are generous in their range.

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Telegrams: Bescotools Norwest London

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Telephones: CENtral 7606-8
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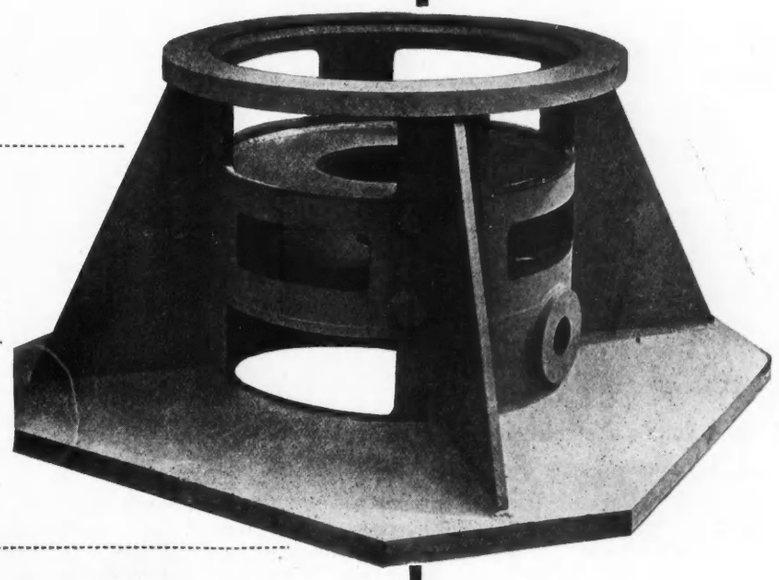

A Fabricated Mild Steel Vertical Thrust Housing with Oiltight Chamber. Machining allowance of ¼" on all finished surfaces.

Photograph by courtesy of Michell Bearings Ltd., Newcastle-upon-Tyne.

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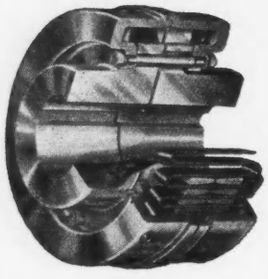

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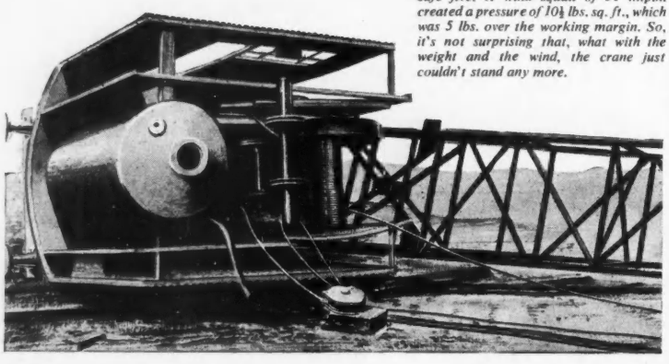

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Hathernware may be considered as a complete processing installation, piping, towers, filters, pumps, etc.—as storage units of different shapes and sizes or as a material for the protection of structures and plant.

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Hathernware specialised design experience plus armouring of elements where required, eliminates the usual risks of fracture. The high compressive strength of Hathernware offers the maximum resistance to abrasion. EXPERIENCED CERAMIC FITTERS undertake initial installation.

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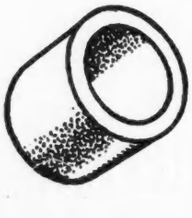
If it's corrosive—write and find out what Hathernware can provide. Mention your process so that we may select the most appropriate data.



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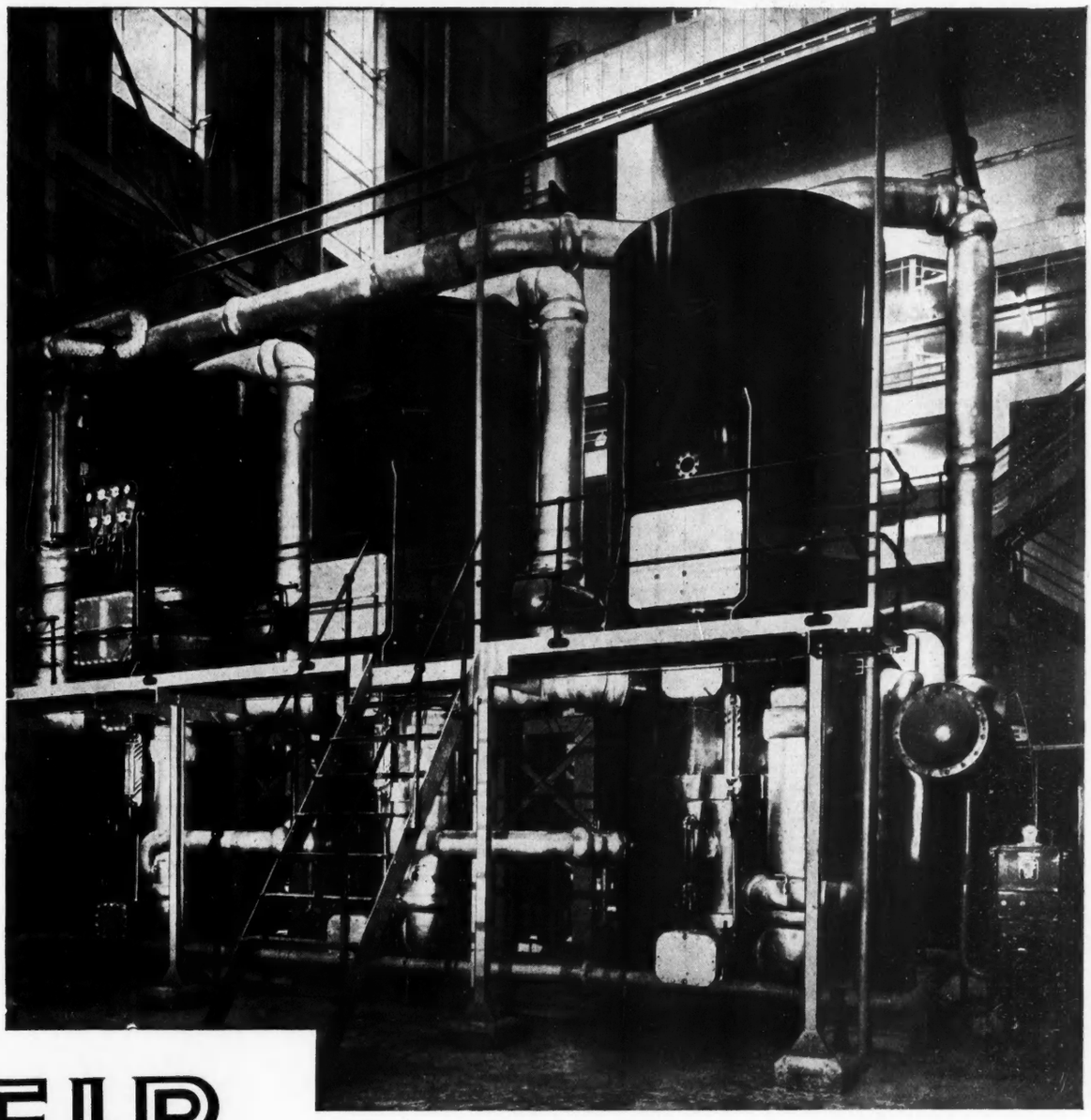

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for the production of pure water for boiler feeding and for industrial or domestic use

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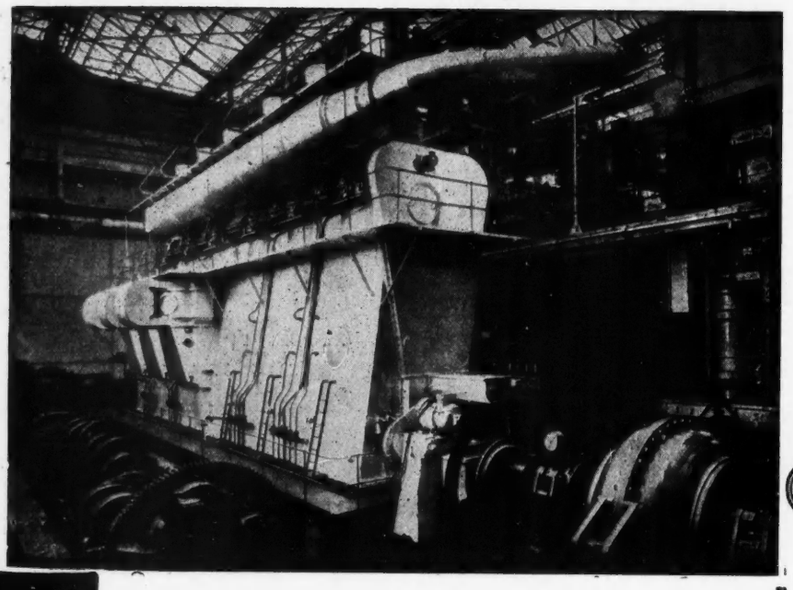

Doxford Diaphragm engine on test. The photograph was taken whilst the engine was running at 103 r.p.m. and developing 7,750 b.h.p.

DOXFORD

diaphragm engine

CRANKCASE ISOLATION AGAINST CORROSION
LOWER PISTON OIL OR WATER COOLED AS DESIRED

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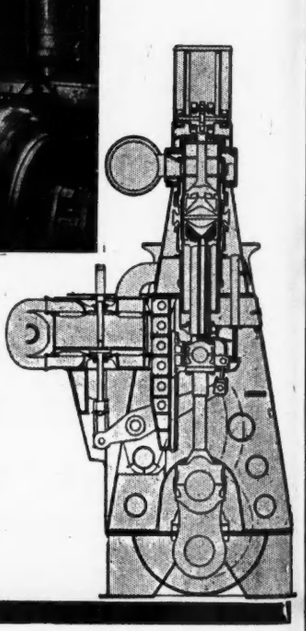

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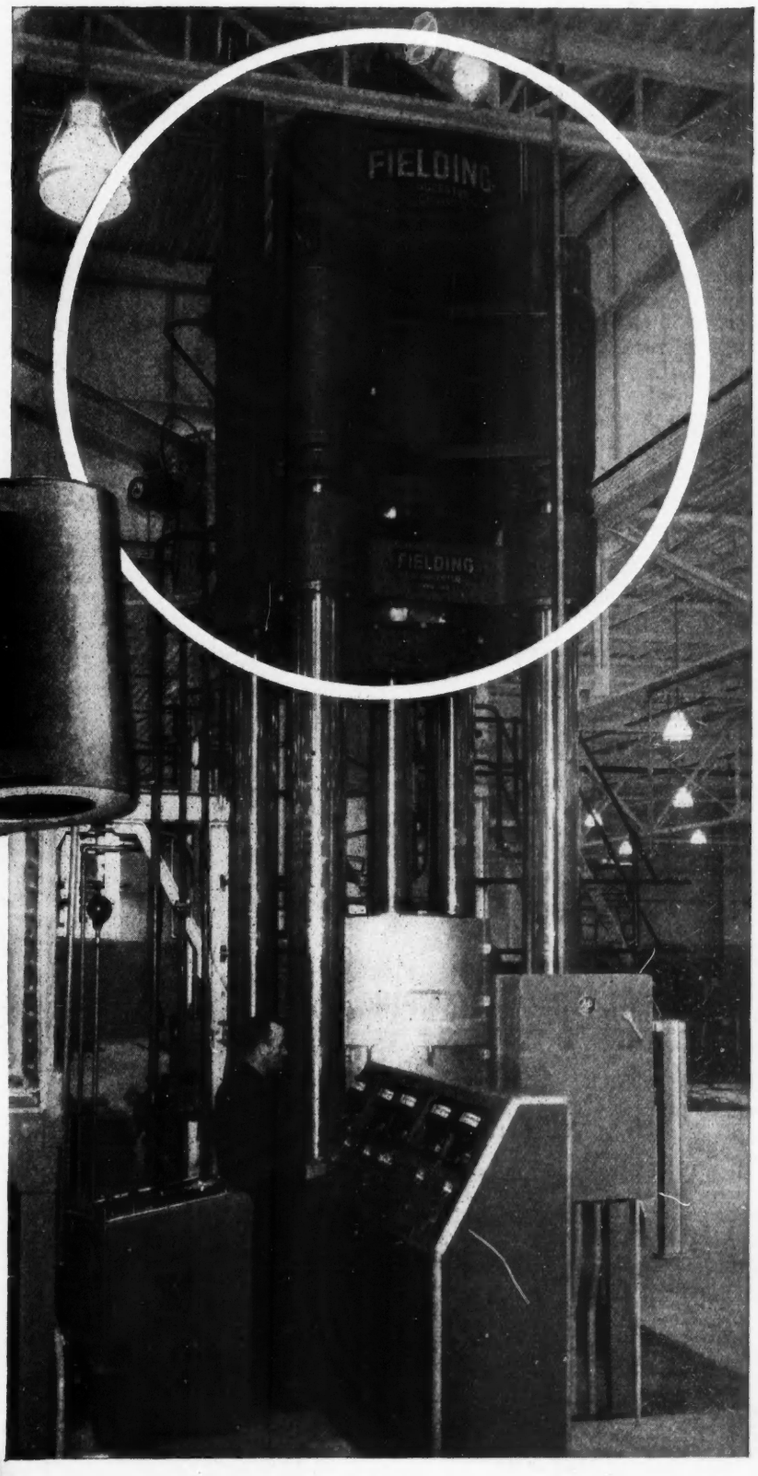

This is one of the steel castings supplied by Jarrow Metal Industries Ltd. to Fielding & Platt for their 2,500 ton "FIELDING" Lead Cable Sheathing Press. The casting shown is a main Cylinder with integral top Table, weighing 23½ tons as cast, and of material of an ultimate stress 31·6 tons/sq. ins., yield stress 20·4 tons/sq. ins., elongation on 2" 30%.

Other Jarrow castings used in this Press were :—

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Moving Table.
Drawback Cylinders (2).
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Photographs by courtesy of Messrs. Fielding & Platt Limited.

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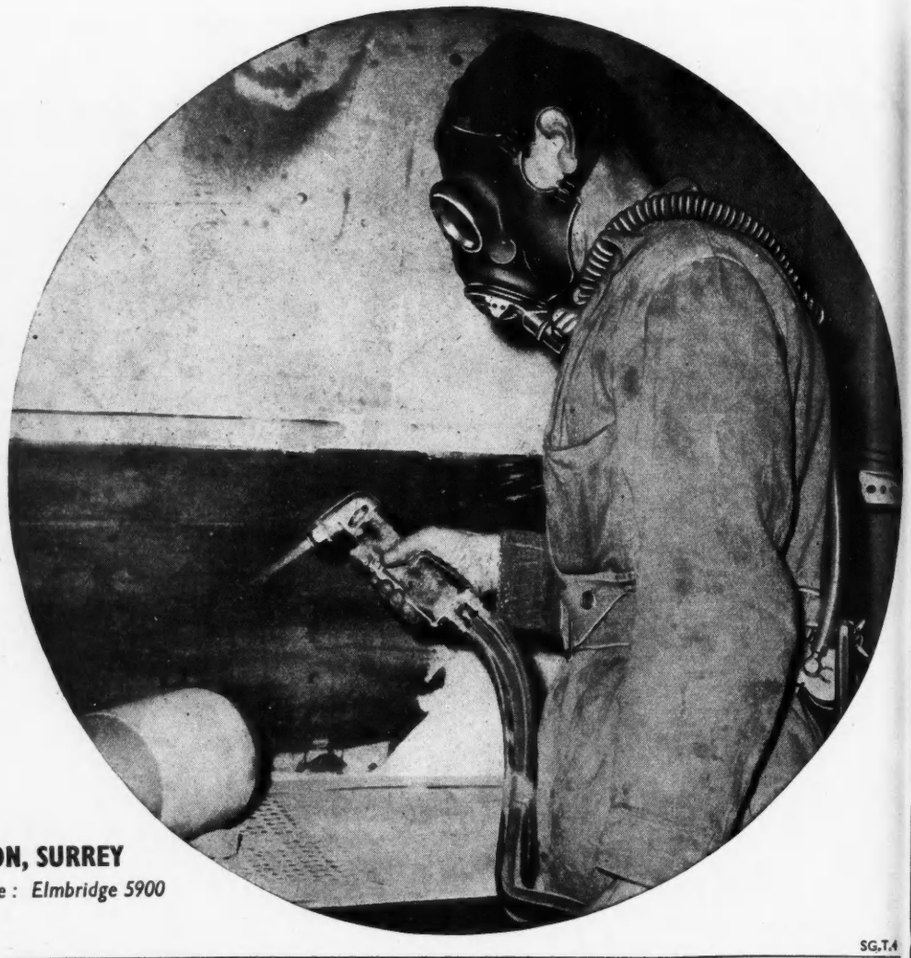

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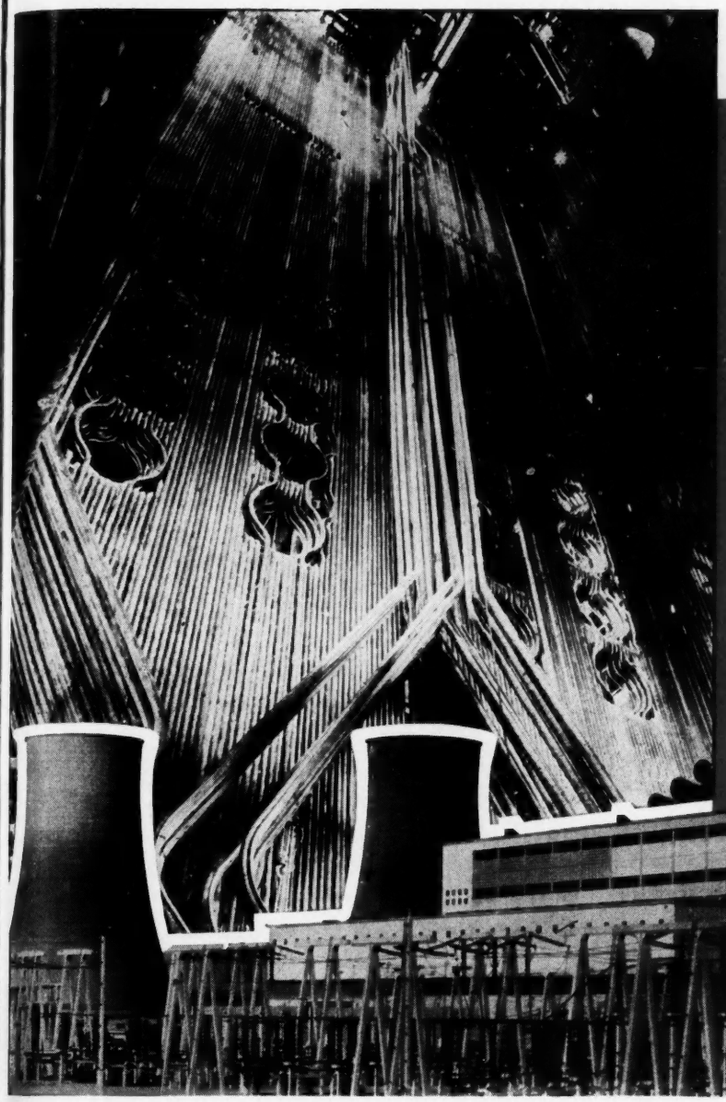
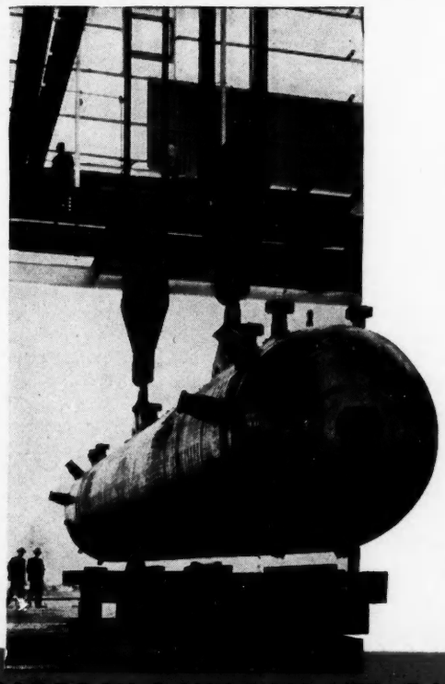


Largest boiler units operating in Europe are BABCOCK

Castle Donington power station, now feeding into the 132 kV Grid will also feed into the 275 kV Supergrid. Left: View into boiler furnace during erection.

Below: Lifting one of the boiler drums, weighing 90 tons, to a height of 123 feet.



830,000 lb. per hr./100 MW units at Castle Donington Power Station

CASTLE Donington (C.E.A., East Midlands Division), is the first power station in Europe with single boiler/turbine units of 100 MW rating and its boilers are the largest in operation in Europe.

Ultimately there will be six pulverized-fuel-fired, twin-furnace, Radiant-type boilers each with a capacity of 830,000 lb./hr. M.C.R., supplying steam at 1,600 lb./sq. in. and 1060°F. The coal-handling plant serving this installation is the largest in Britain, with a designed capacity of 960 tons/hr.

The whole of the boiler plant, including the thirty type-E coal-pulverizing mills and the entire soot-blowing installation, the coal-handling plant and the 'Hydrojet' and 'Hydrovac' ash and dust-handling systems, are of BABCOCK design and manufacture.

The Company has subsequently received orders for boilers of twice this capacity, to steam 200 MW generators, and is engaged in the design of even larger units. Such is the progress of technical development—always with BABCOCK in the front rank.

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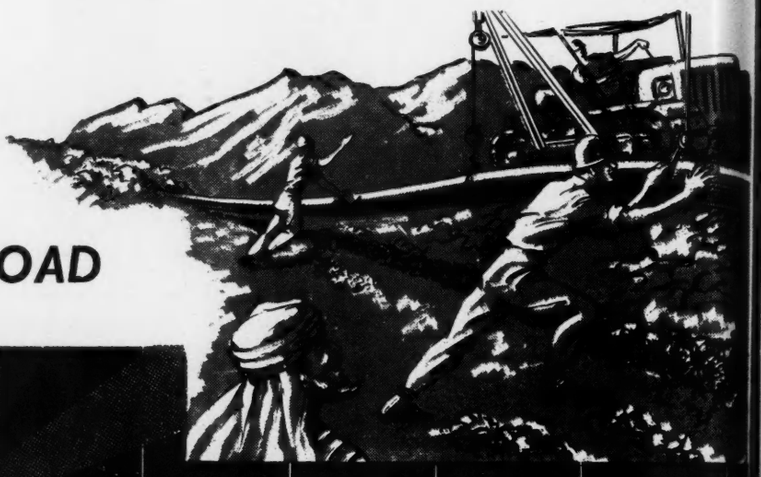

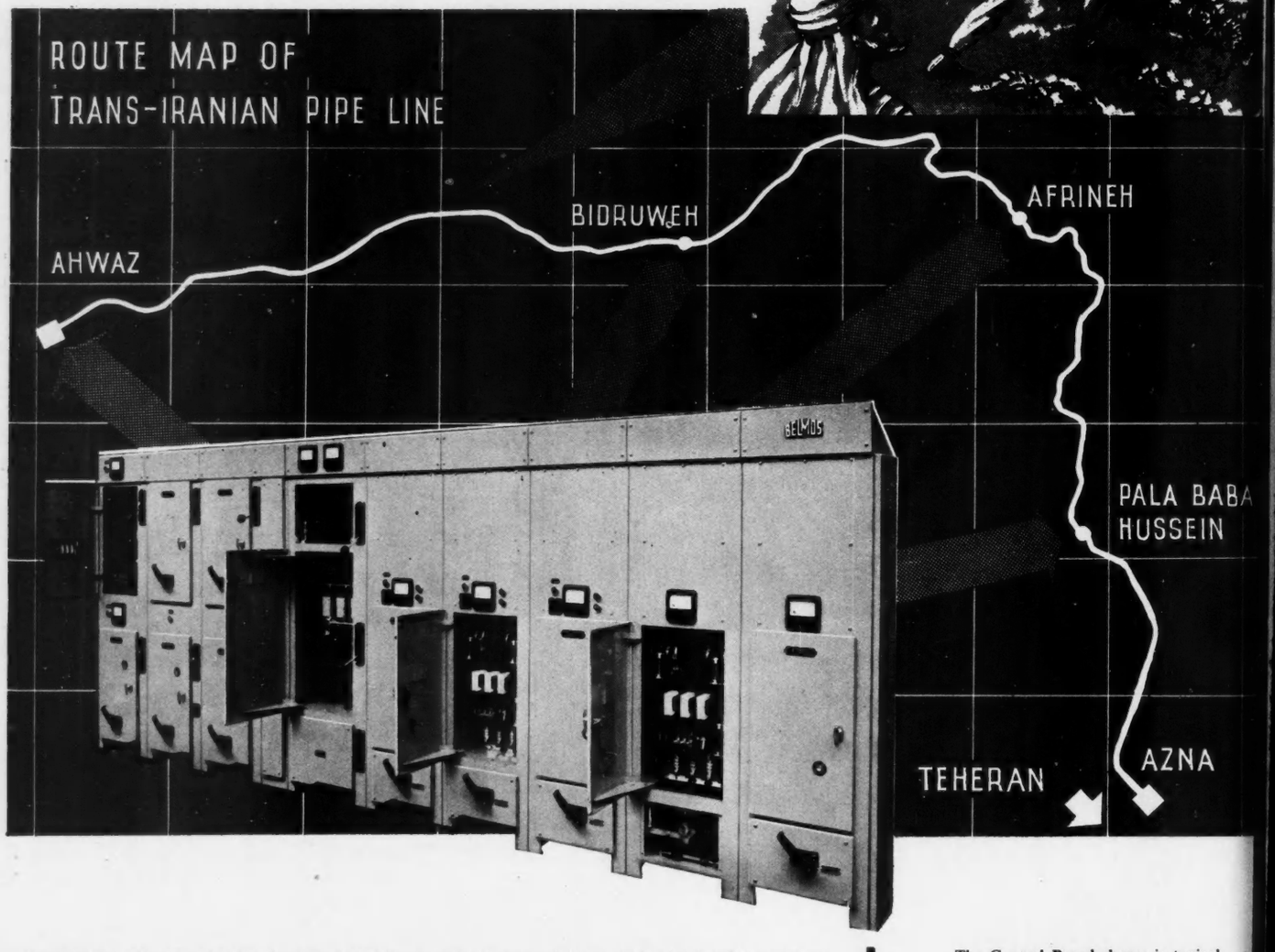

Running for 300 miles, the Trans-Iranian oil pipeline connects the town of Ahwaz (a focal point of the existing crude oil pipeline system sixty miles north of Abadan), to the town of Asna, forming the southern part of a project which, in all, will stretch from Abadan to Teheran ; the line from Abadan to Ahwaz being already in existence, while the Northern section from Asna to Teheran is being laid by a French firm. The completed pipeline will cover some 580 miles and will convey Gas Oil, Kerosene and Motor Spirit.

There are four pumping stations between Ahwaz and Asna, each station being similar in engine capacity (1,500 H.P.). The main control gear for the electrically operated pumps and compressors at each station comprises a Belmos Group Motor Control Board of the industrial type with appropriate remote control stations—the latter including flameproof units at hazardous locations.

Much of the pipeline crosses difficult mountainous terrain, reaching a height of nearly 7,000 feet above sea level. The present stage has a capacity of 1,000,000 tons a year and provision has been made for doubling this, together with extra pumping stations.

The Control Board shown is typical of the four supplied, and comprises an incoming air-break circuit breaker, five stator/rotor starters for slip ring motors, and four direct-on line starters for squirrel cage motors, with an additional feeder circuit at AHWAZ only.

Acknowledgements :—

We are indebted to Messrs. Costain-John Brown Ltd., who designed and constructed the pipeline project as main contractors, for permission to use the information given.

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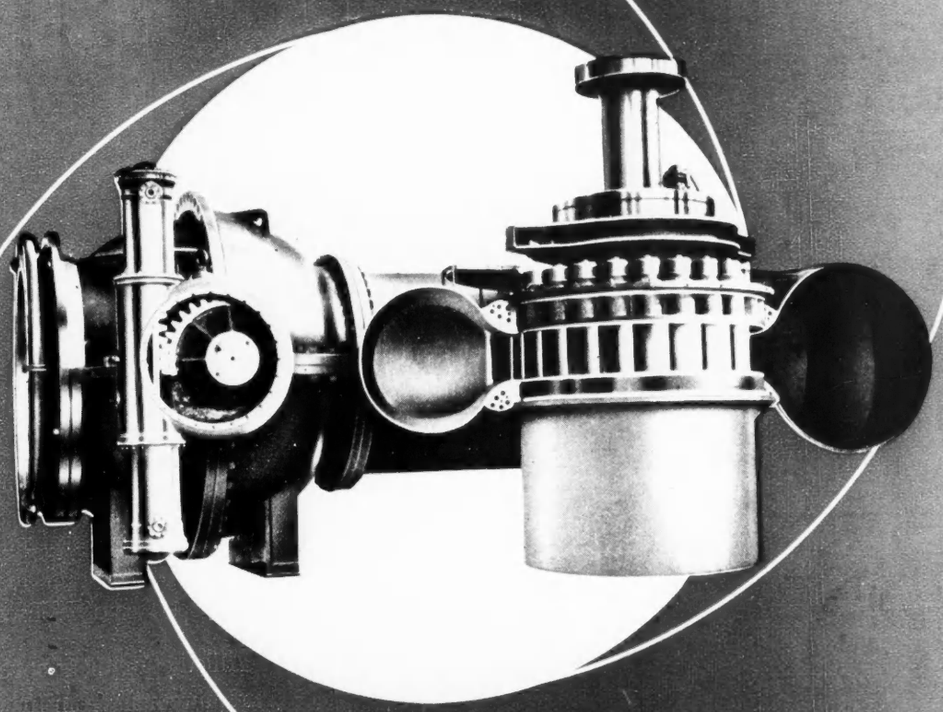

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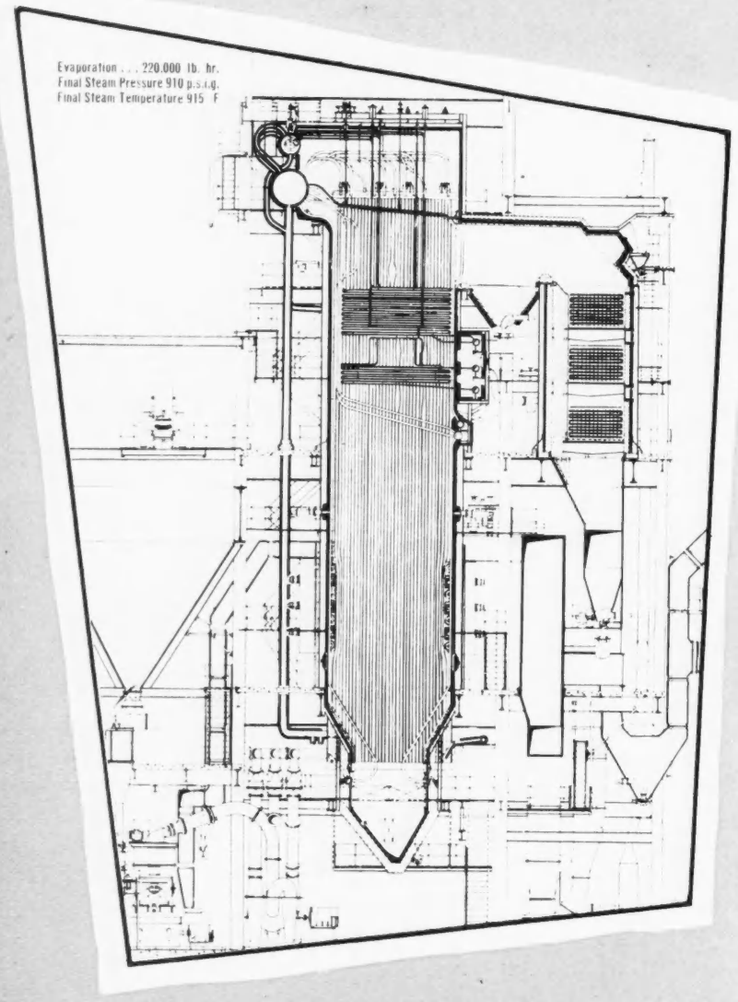

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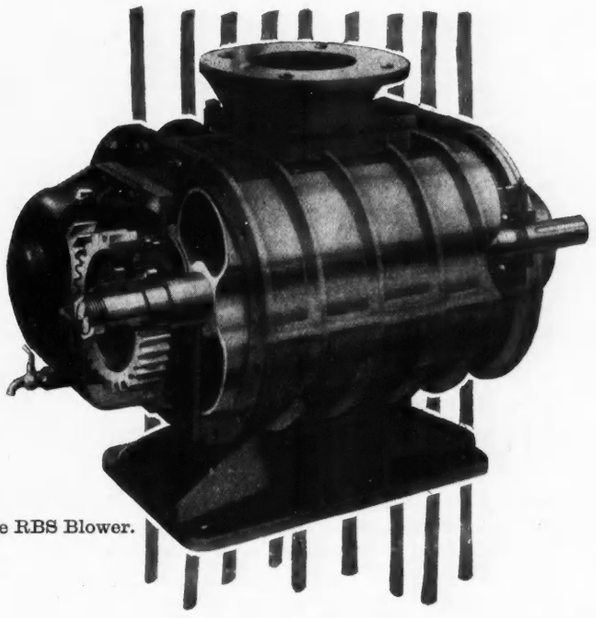

A cut-away view of the RBS Blower.

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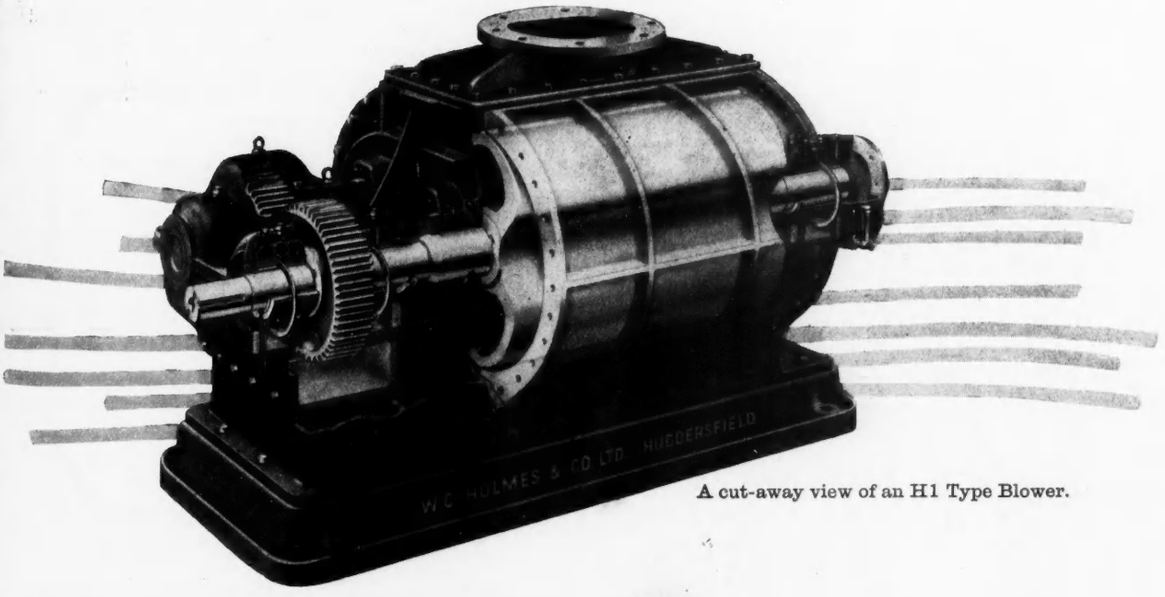

A cut-away view of an H1 Type Blower.

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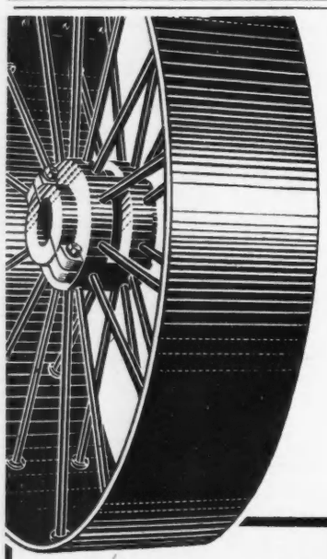

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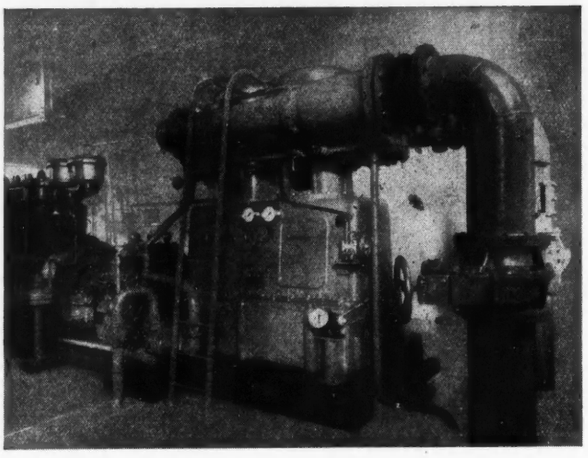

Bryan Donkin Compressor at Shepton Mallet Gasworks powered by Lister Blackstone engine.

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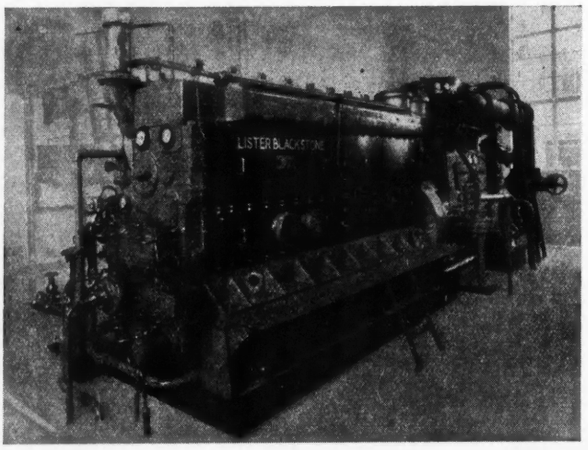

450 h.p., 8 cylinder Lister Blackstone "ER8" engine driving the above gas compressor

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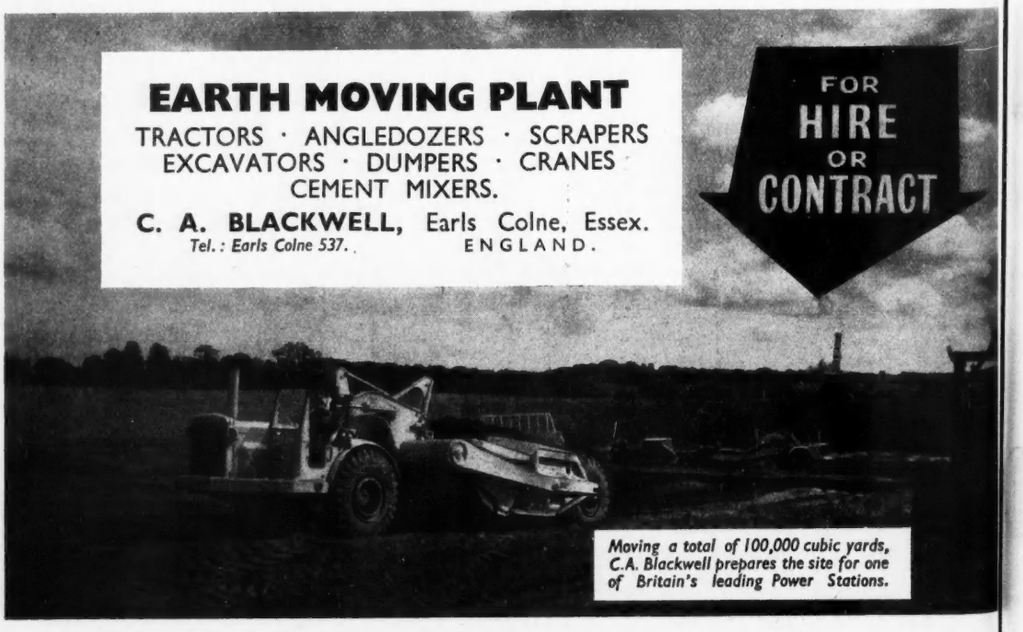

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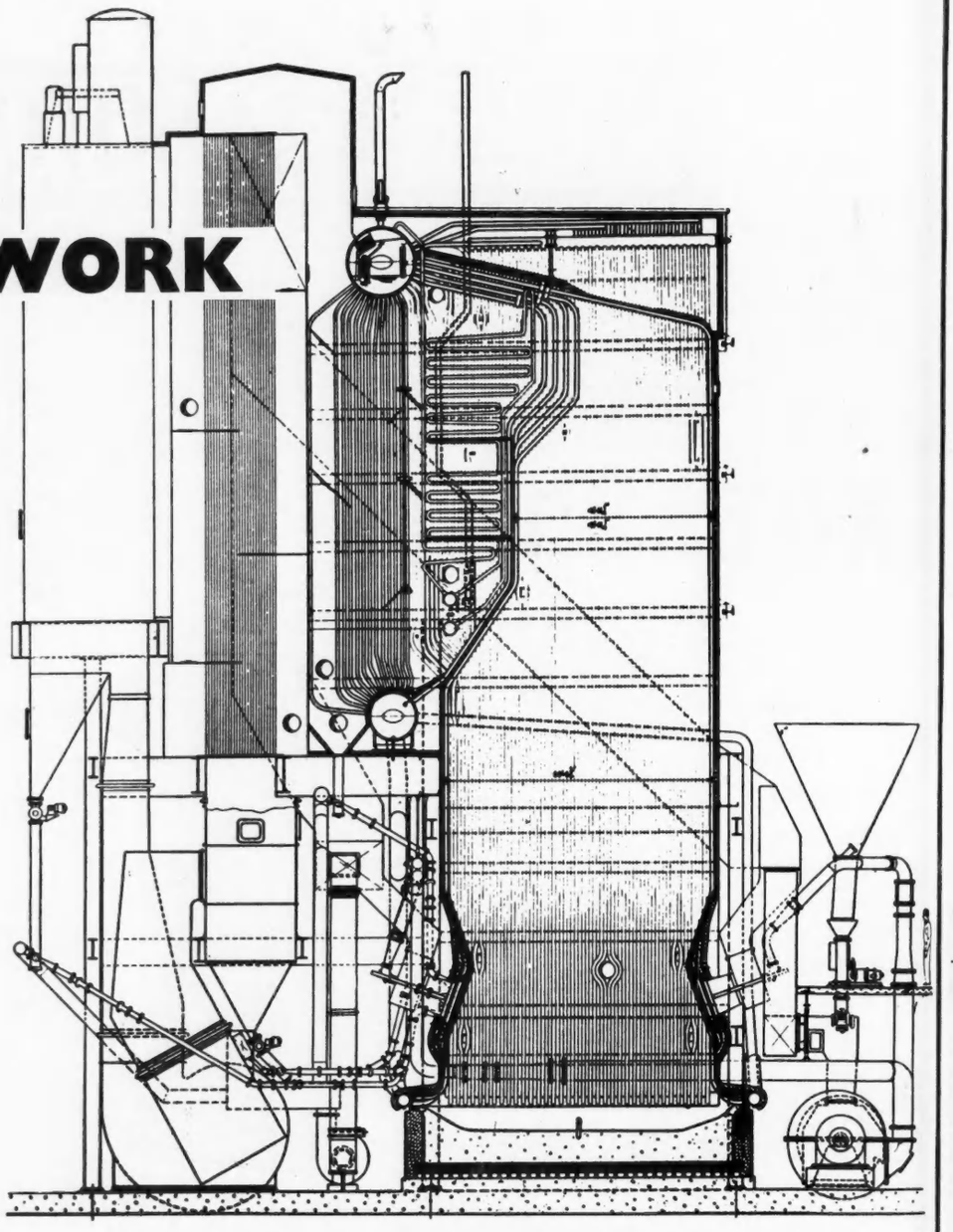

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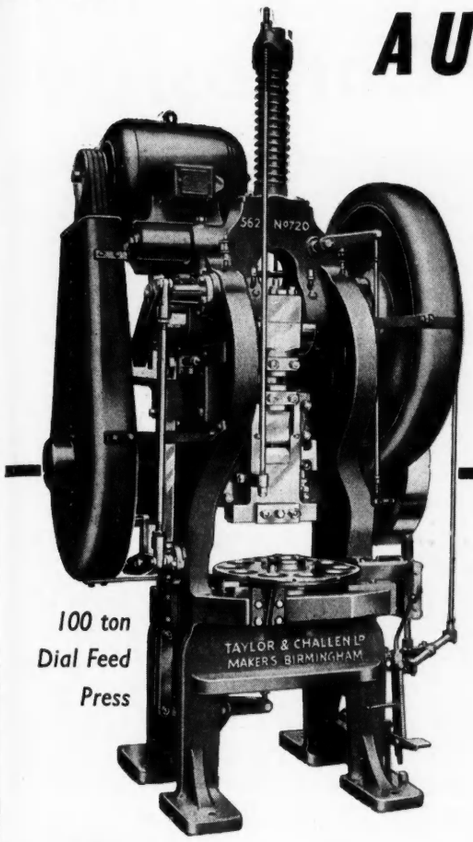
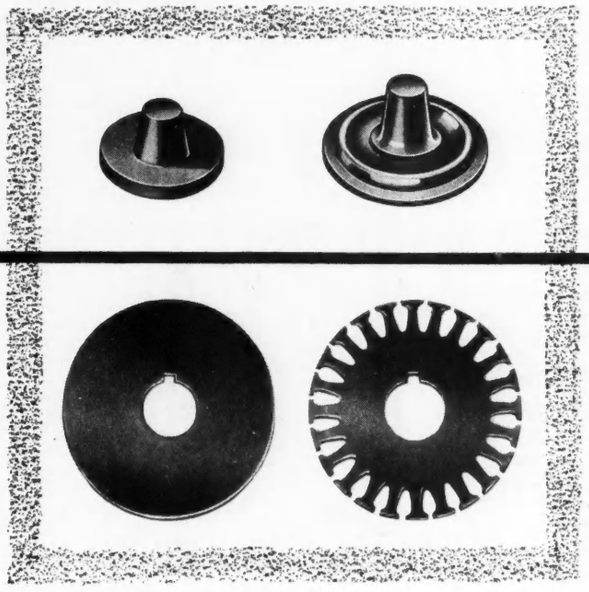


100 ton Dial Feed Press



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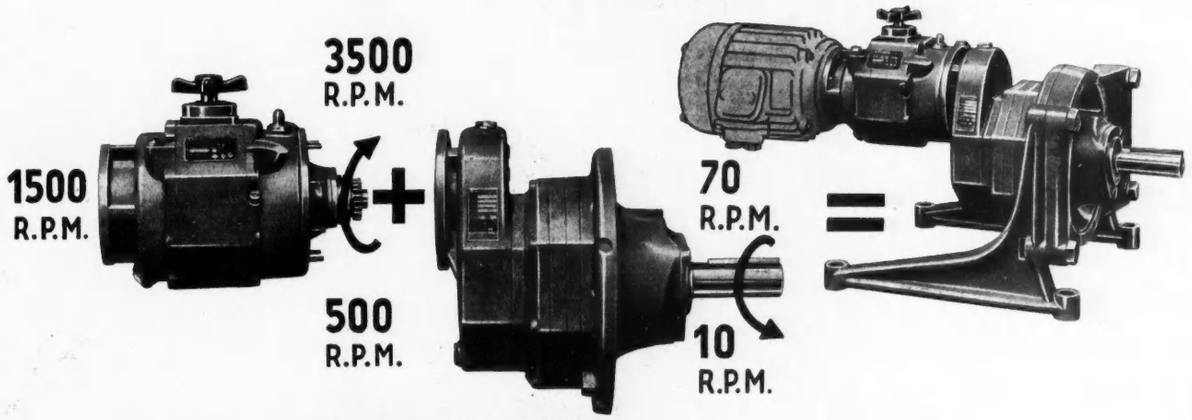

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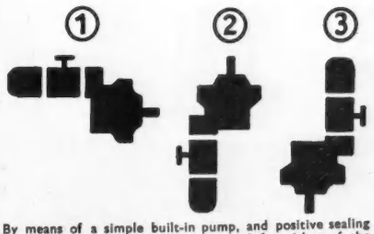

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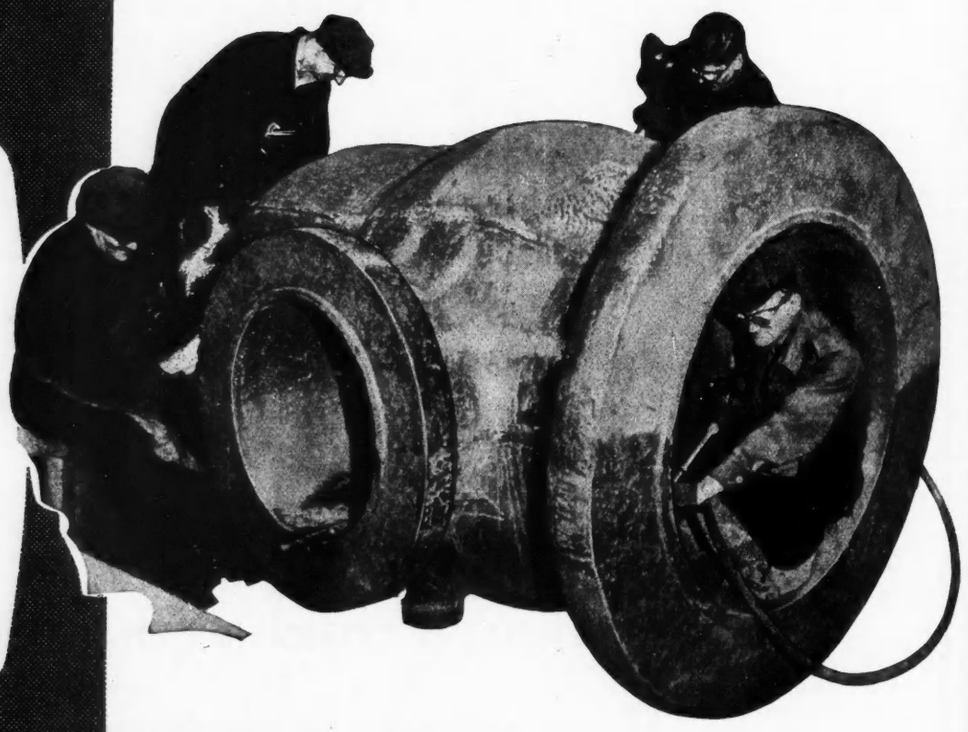

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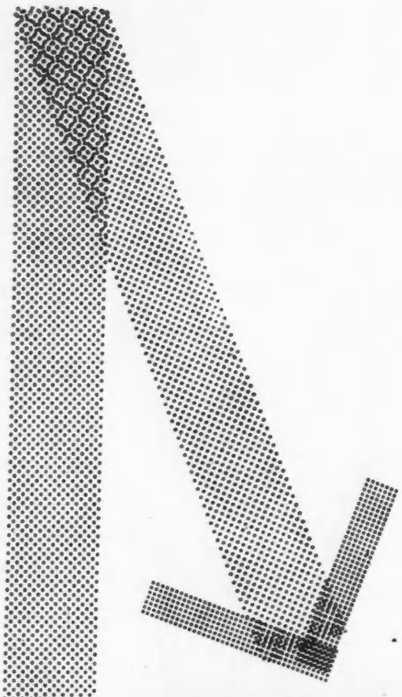
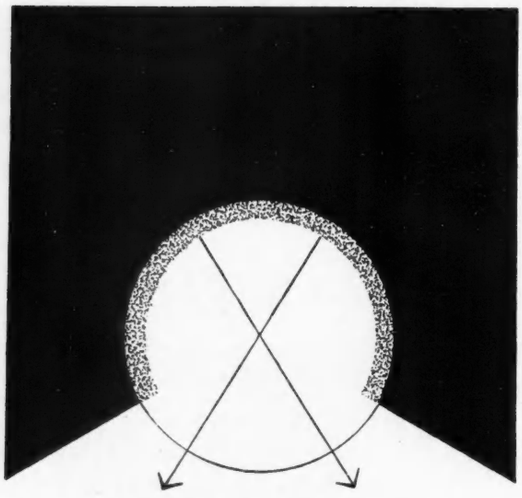


How much light are **you** wasting through dust?



This cross-section of a "Reflectalite" tube shows the diffusing, reflecting layer of powder inside the glass, which covers approximately 240° of the circumference.

From the day it's installed, the normal fluorescent tube steadily loses efficiency. Why? Because it is almost impossible to prevent dust and dirt from settling on the top and sides of the tube. Impossible, that is, without very frequent cleaning and the additional cost it entails.

Philips "REFLECTALITE" puts an end to all that

"Reflectalite" is a fluorescent tube with a built-in reflector. Two-thirds of the tube — that 240° segment where dust and dirt most easily settle — are internally coated with a special powder prior to the application of the normal fluorescent phosphor. The majority of the light output from the tube is therefore reflected down through the 120° "window", as shown in the diagram

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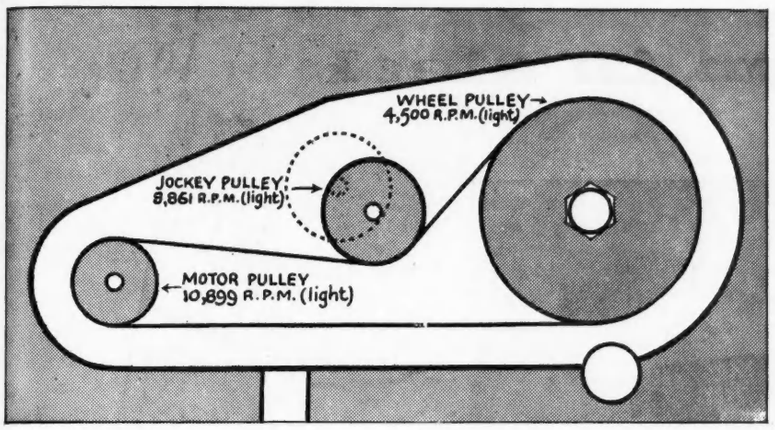

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in the WOLF Heavy Duty Valve Refacer

Permali was selected as the material for the three pulleys in this compact high-speed drive, because of the silent-running and high-precision characteristics obtainable, together with Permali's unique combination of lightness, strength and resistance to wear. Drawing, reproduced by courtesy of WOLF Electric Tools Limited, show position of the motor, jockey and wheel pulleys, all of Permali, which transmit the drive to the grinding wheel.

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- *ROBUST*
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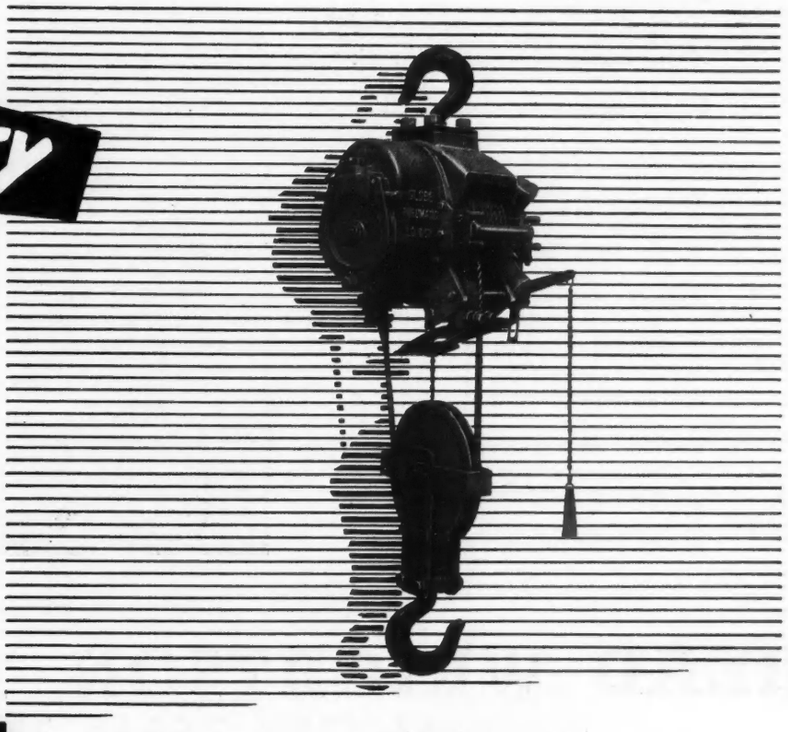

AIR HOISTS

The
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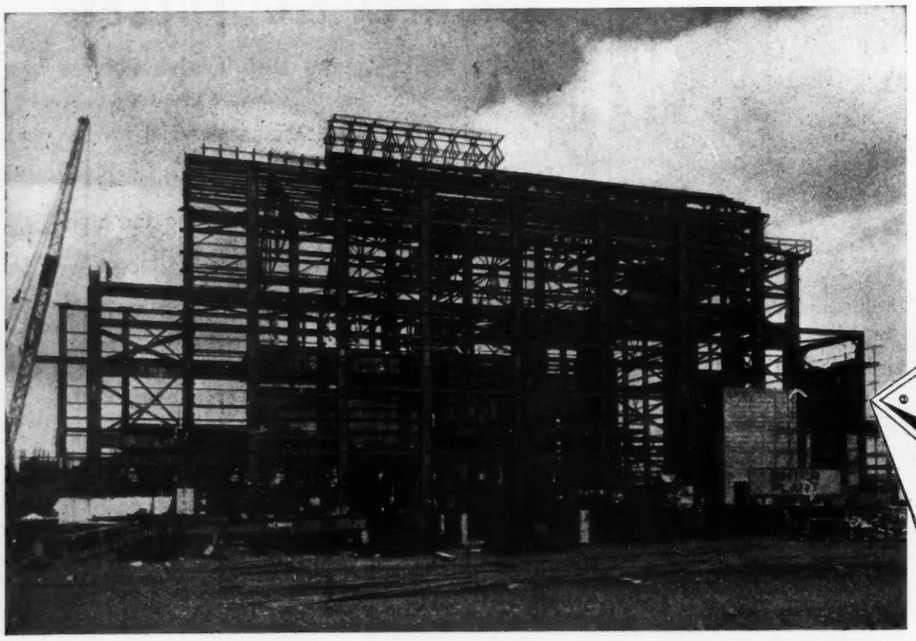
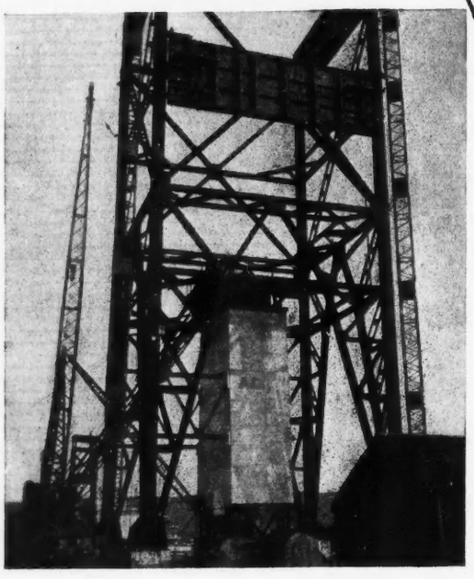
construction in steel



The constructional Department of Head Wrightson produces steelwork for industrial constructions of all types, chemical, gas, iron and steel, etc. The lower photograph shows the 200 ft. Winder Tower built for the Rufford Colliery of the National Coal Board. 750 tons of steel were used in this construction. The illustration above shows the Sinter Plant Building constructed for Messrs. John Summers & Co. Ltd.



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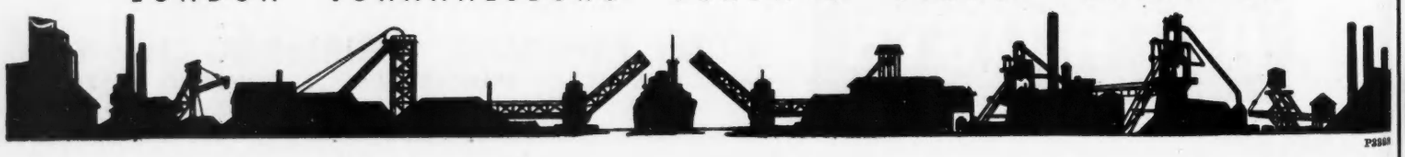
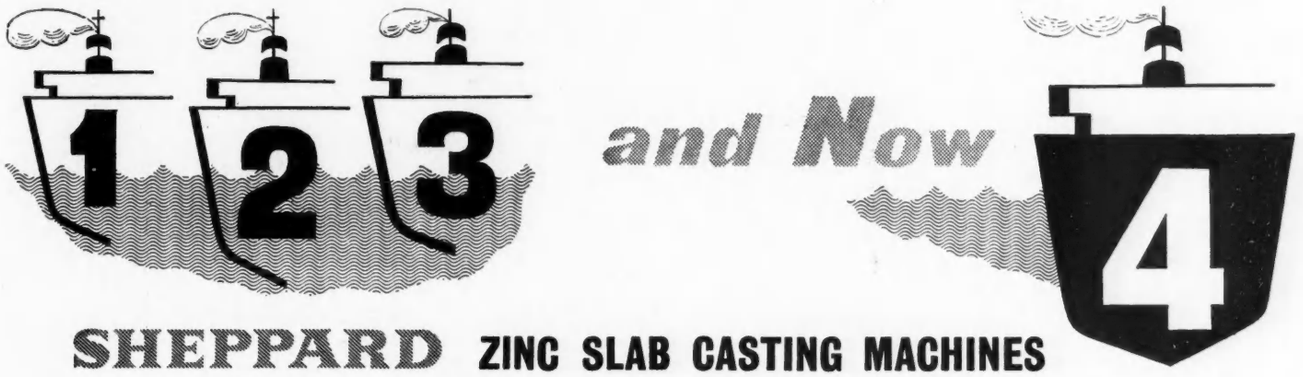
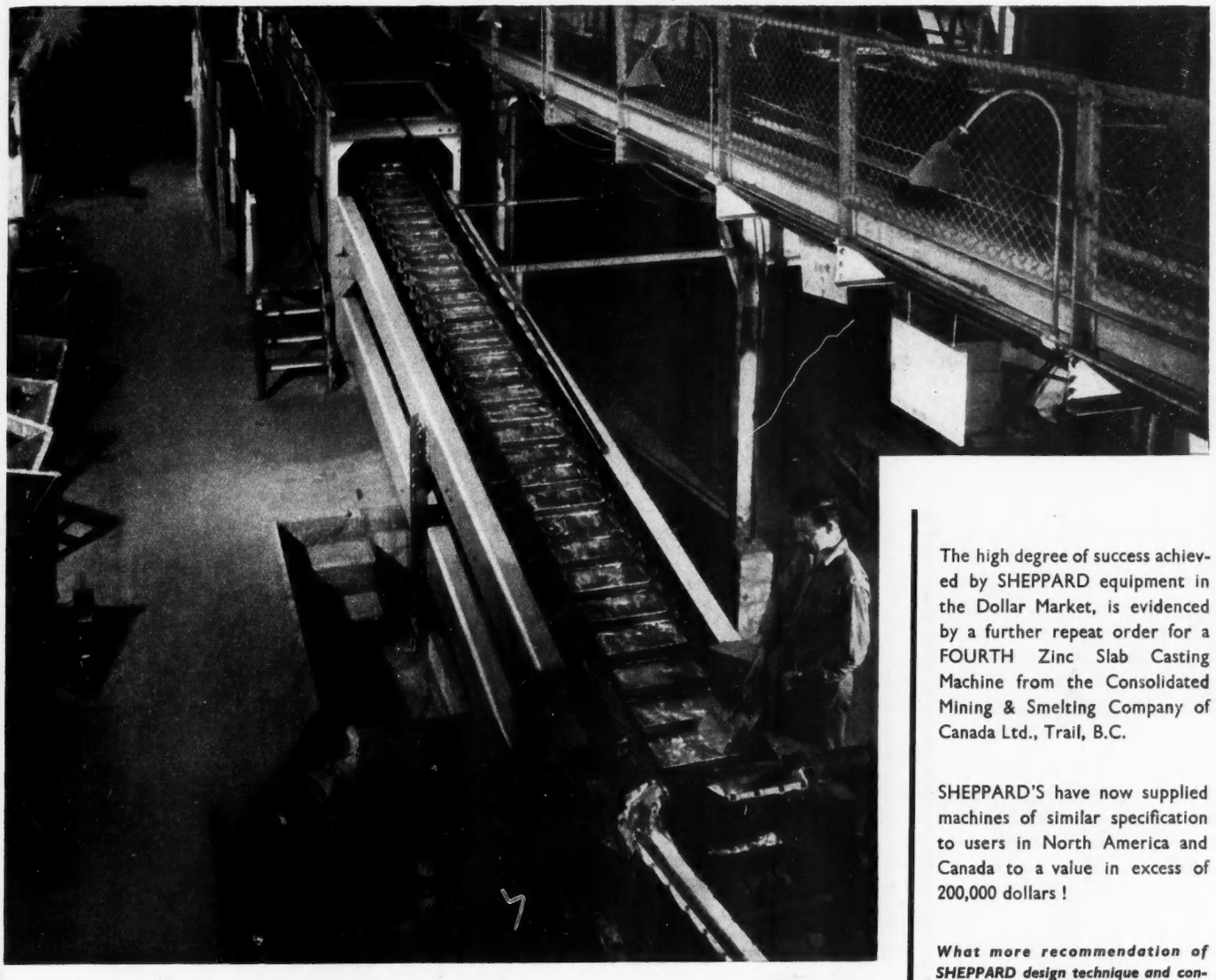




SHEPPARD ZINC SLAB CASTING MACHINES supplied to CANADA



The high degree of success achieved by SHEPPARD equipment in the Dollar Market, is evidenced by a further repeat order for a FOURTH Zinc Slab Casting Machine from the Consolidated Mining & Smelting Company of Canada Ltd., Trail, B.C.

SHEPPARD'S have now supplied machines of similar specification to users in North America and Canada to a value in excess of 200,000 dollars !

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LATEST NEWS

BELGIUM ORDERS SHEPPARD ZINC SLAB CASTING MACHINE !

Recently, an order was received for a similar machine to the value of £12,000 from Societe des Mines et Fonderies de Zinc de la Vieille Montagne, Balen Nethe, Antwerp.

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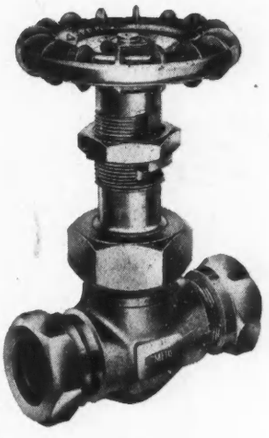

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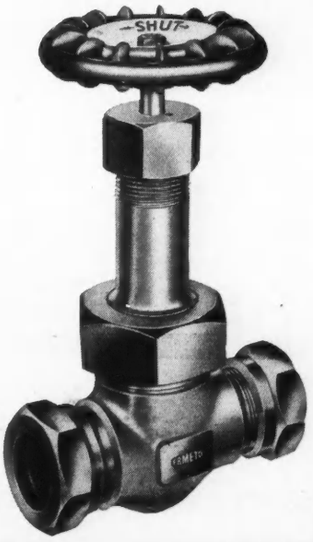

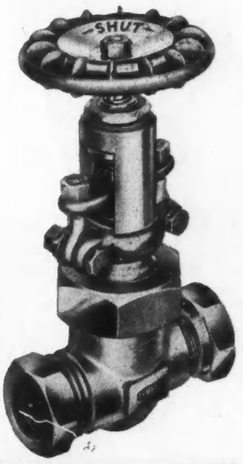

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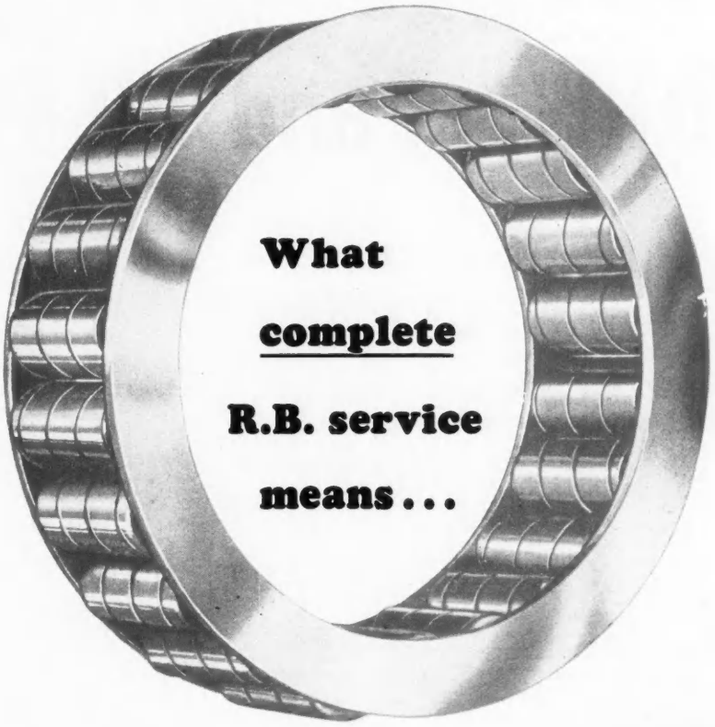

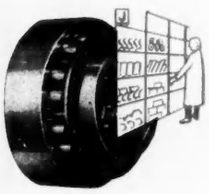

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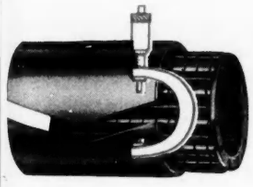

It means that quality of product is maintained at the highest level. At Salter, this is done by using the most modern production machinery and exacting inspection methods.

Grinding the press tool for producing roller bearing cage-ends. This new jig-grinding machine is accurate to .0001" and grinds the tools after they have been hardened. Such accuracy in the tool making is obviously reflected in the precision and quality of the bearings we produce.

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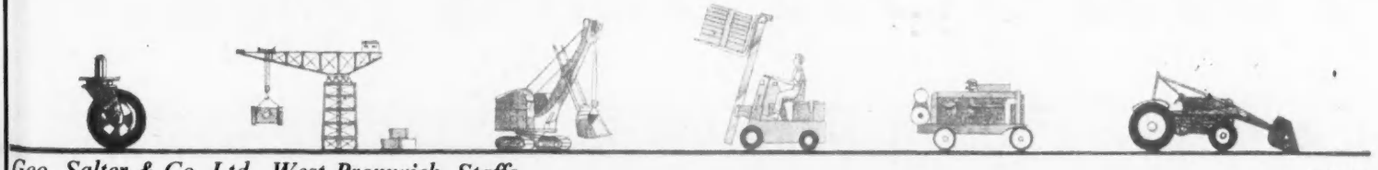

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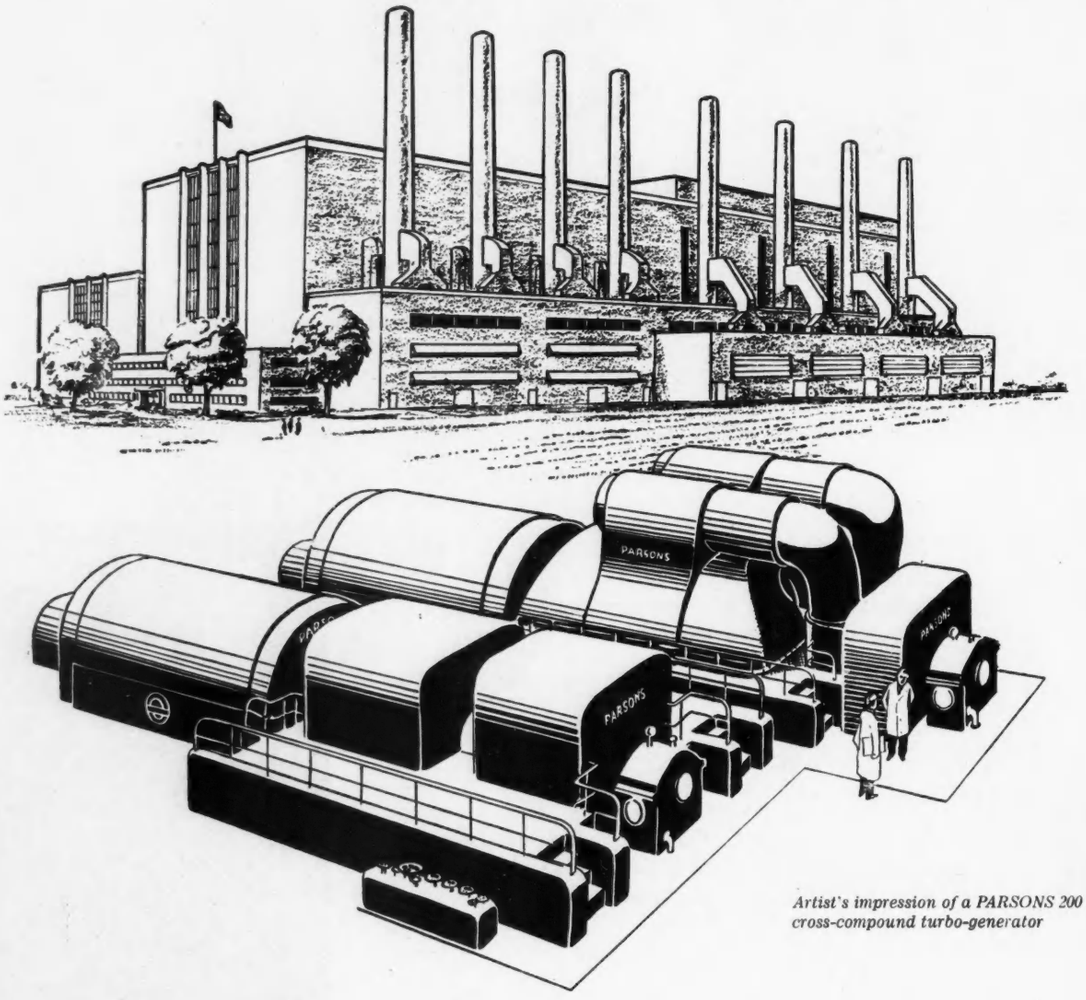
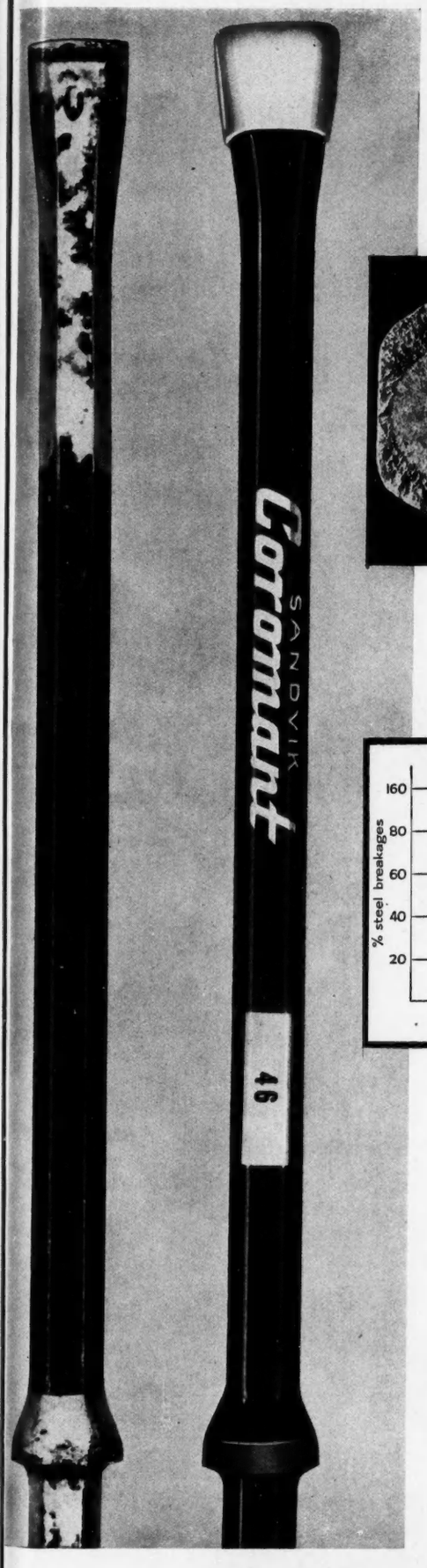


Artist's impression of a PARSONS 200 MW cross-compound turbo-generator

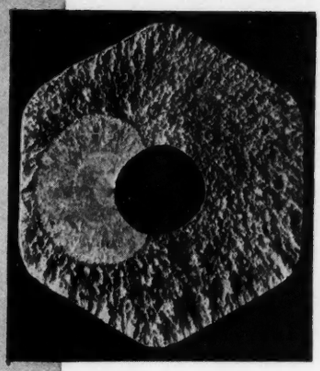
The Hydro Electric Power Commission of Ontario, Richard L. Hearn generating station at Toronto when fully extended will be the largest power station in the world with all turbo-generators from one manufacturer. The first four machines to be installed are Parsons 100 MW type. These are now being implemented by the addition of four 200 MW Parsons cross-compound sets raising the station output to 1,200,000 kW. On these later machines the H.P. lines will run at 3,600 r.p.m., and the L.P. lines at 1,800 r.p.m., a single generator developing 100 MW being coupled to each line . . . Steam conditions, 1,800 lb/ins.² Temperature 1,000° F. Reheat temperature 1,000° F.

PARSONS turbo-generators

C. A. PARSONS & CO. LTD., HEATON WORKS, NEWCASTLE UPON TYNE, 6



SR—the new Sandvik Coromant treatment gives steels 50% longer life

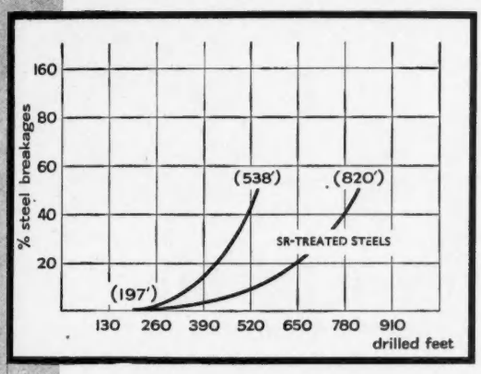


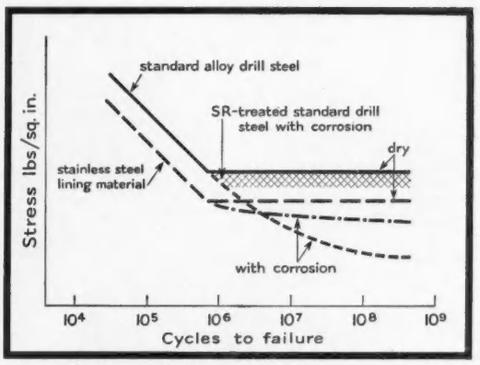
Corrosion invariably lessens the fatigue strength of drill steels and causes earlier breakages. The breakages start from corrosion craters and indentations, around which ever-widening areas of worn surfaces are formed. (See picture of cross-section.)

The main cause of corrosion is moisture—so effective protection of the steels against moisture during both storage and actual drilling eliminates corrosion and gives longer life to the steel. This protection is given to Coromant integral steels by the SR treatment, a new exclusive Sandvik feature.

PRACTICAL TESTS GIVE CONCLUSIVE PROOF

The diagram on the left shows clearly that SR-treated steel rods have a 30%—50% longer working life than those of untreated steels. Figures are based on extensive practical tests, which resulted in an average drilling depth of 820 ft. for SR-treated steels as against 538 ft. for untreated steels, before rod breakage.





HOW SR TREATMENT PREVENTS CORROSION

SR treatment is a new method of surface protection developed by Sandvik. It protects both the wall of the flushing hole and the outer walls from corrosion by a thin but strongly adhesive layer. The fatigue properties of the steels therefore correspond to those valid under dry conditions. On the wall of the centre hole, usually subjected to water flushing, the SR layer is everlasting, and *does not decrease the diameter of the flushing hole.* This is a distinct improvement on the old means of coating the centre hole with stainless steel, which lessens the diameter of the flushing hole, prevents full and effective flushing, and thus diminishes the drilling rate. Moreover, stainless steel has a lower fatigue strength than standard alloy drill steel. Sandvik Coromant drill steels have been closely developed together with Atlas Copco rock drills. This drilling combination has for years been the most widely used in the world.

Sandvik Coromant integral steels, extension steels and detachable bits are supplied by Atlas Copco. It is the largest group of companies specialising solely in the development and manufacture of compressed air equipment. It embraces Atlas Copco companies or agents manufacturing or selling and servicing Atlas Copco equipment in ninety countries throughout the world. For further details of the equipment featured here, contact your local Atlas Copco company or agent, or write to Atlas Copco (Great Britain) Limited, Beresford Avenue, Wembley, Middlesex or Atlas Copco AB, Stockholm 1, Sweden.

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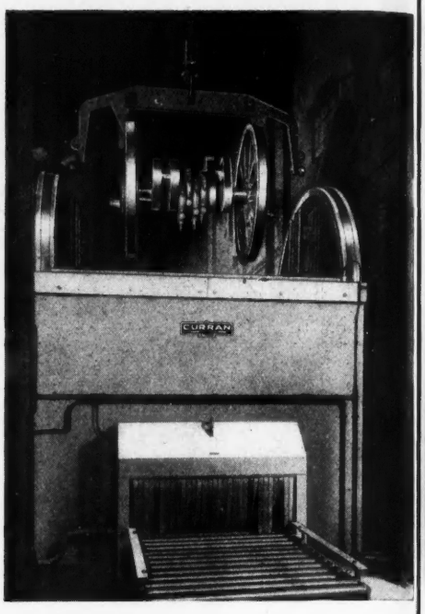
Roll-Chock in position for cleaning.



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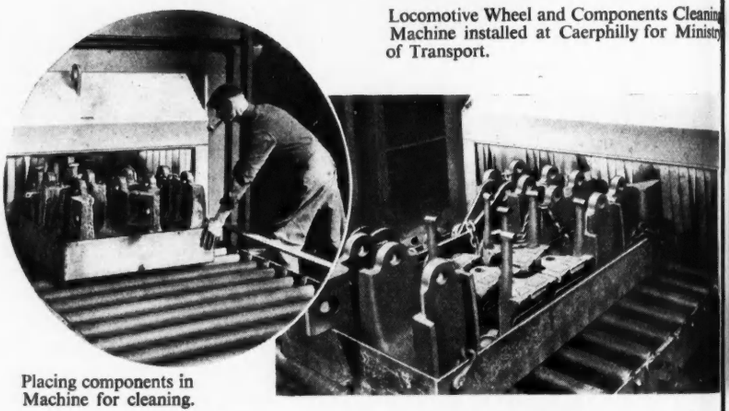

Placing components in Machine for cleaning.

Components emerging thoroughly cleaned

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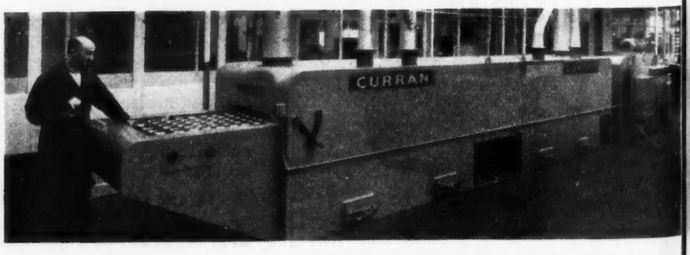

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Our experience is at your service—

if you are thinking of installing oxygen or gas separation plant, be sure and consult BRITISH OXYGEN LINDE. Our advice is free, and your enquiries, however preliminary, will be welcomed.

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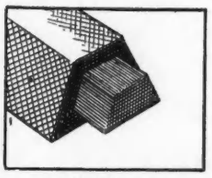
ABOUT DRIVES



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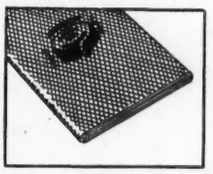
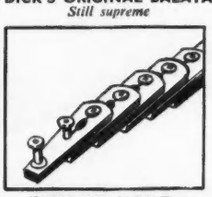


DICK'S ORIGINAL BALATA
Still supreme



DIXLINK V-BELT
Saves dismantling costs

"DICK'S BELTS AND ROPES TRANSMIT POWER MORE EFFICIENTLY AT LOWER COST"

V-BELTS AND ROPES. Dickrope-plus for high speed machinery and short centre drives gives up to 33⅓% more power than standard vee belts. Dixel V-Rope for drives up to 2,000 h.p. will transmit more power with fewer ropes. It can be spliced endless with solution and rivets or with our "Quickfix" bolts. Dixlink V-Belting is detachable and adjustable in a minute. Saves dismantling costs. Suffers no internal fatigue.

GENERAL PURPOSE BELTS. Dick's Original Balata gives powerful, economical transmission free from slip. Weatherproof, flexible and can be spliced endless. Dixylon, a new plastic belt, almost entirely eliminates the effects of centrifugal force. Dixit Belting is resistant to heat, acid fumes and humidity. Dixadd Belting is ideal for high ratio drives. Exerts less bearing pressure than any other form of transmission. Ruberix, a solid woven belt made from filastic yarn treated with latex and vulcanised. Has high coefficient of friction.

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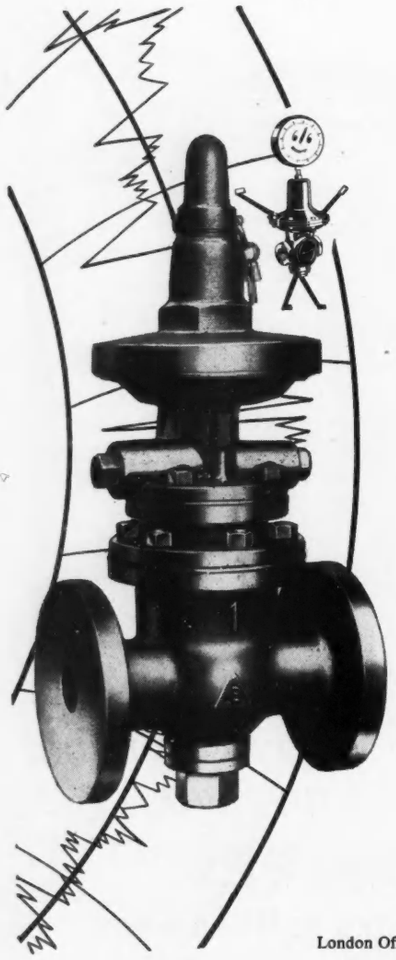

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—with Bailey's NEW Class G3 Foster Pressure Regulators

Bailey's new 'G3' pressure regulators supersede the highly successful 'G2A' series. Stronger construction and greater ease of accessibility for maintenance are special features of this latest series in the Bailey range.

GREATER DURABILITY

The three points where the most wear takes place have been replaced to provide more durability. Pilot valve tops are now of forged bronze or alloy steel and valve and seat materials are harder.

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Spring chambers, pilot valve assembly, and the separate pilot valve strainer are all easily accessible.

EXCELLENT PERFORMANCE

- Close regulation within ± ½ p.s.i. at low reduced pressures.
- Pressure rise only 1% of initial pressure under dead-end conditions.
- Remote reduced pressure supply pipe easily fitted for extra sensitivity, or for more even performance under special conditions.

Please write for leaflet giving full details.

LOCKE'S PATENT "WATERLUTE"

* "Steam-Pressure Regulators and Reducing Valves for Steam and Water.

* These inventions are entirely without springs, Stuffing-boxes, Mercury and Tight Pistons."

This illustration, taken from Bailey's 1888 catalogue, shows the first reducing valve produced in this country. These valves were being manufactured by Bailey well before the Catalogue was published, and are indicative of the high standards maintained throughout the company's 125 years.

Bailey's VALVES

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TGA RV12

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Established 1857

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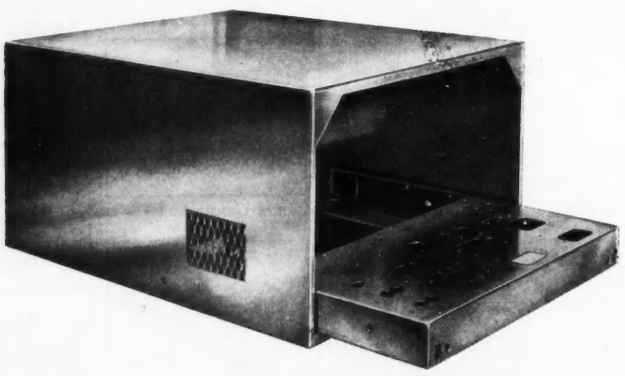
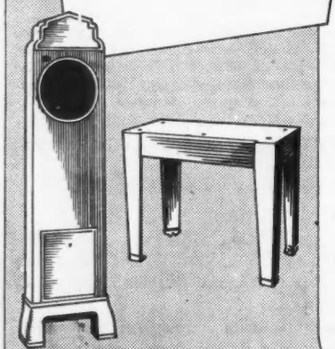
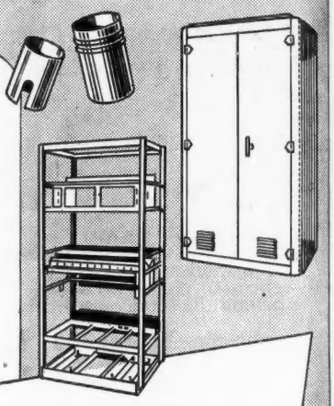
Shown here is a magnesium alloy radio chassis and case manufactured to Admiralty specification.

Argon Arc Welding is employed to give a clean flux-free weld devoid of distortion.







Well-equipped tool-room for the manufacture of the necessary tools to your designs or our own.

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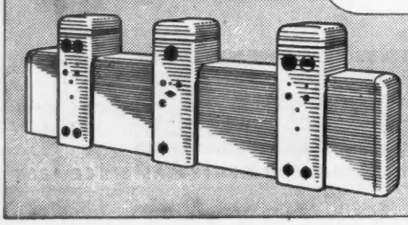

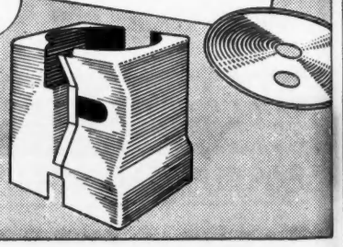

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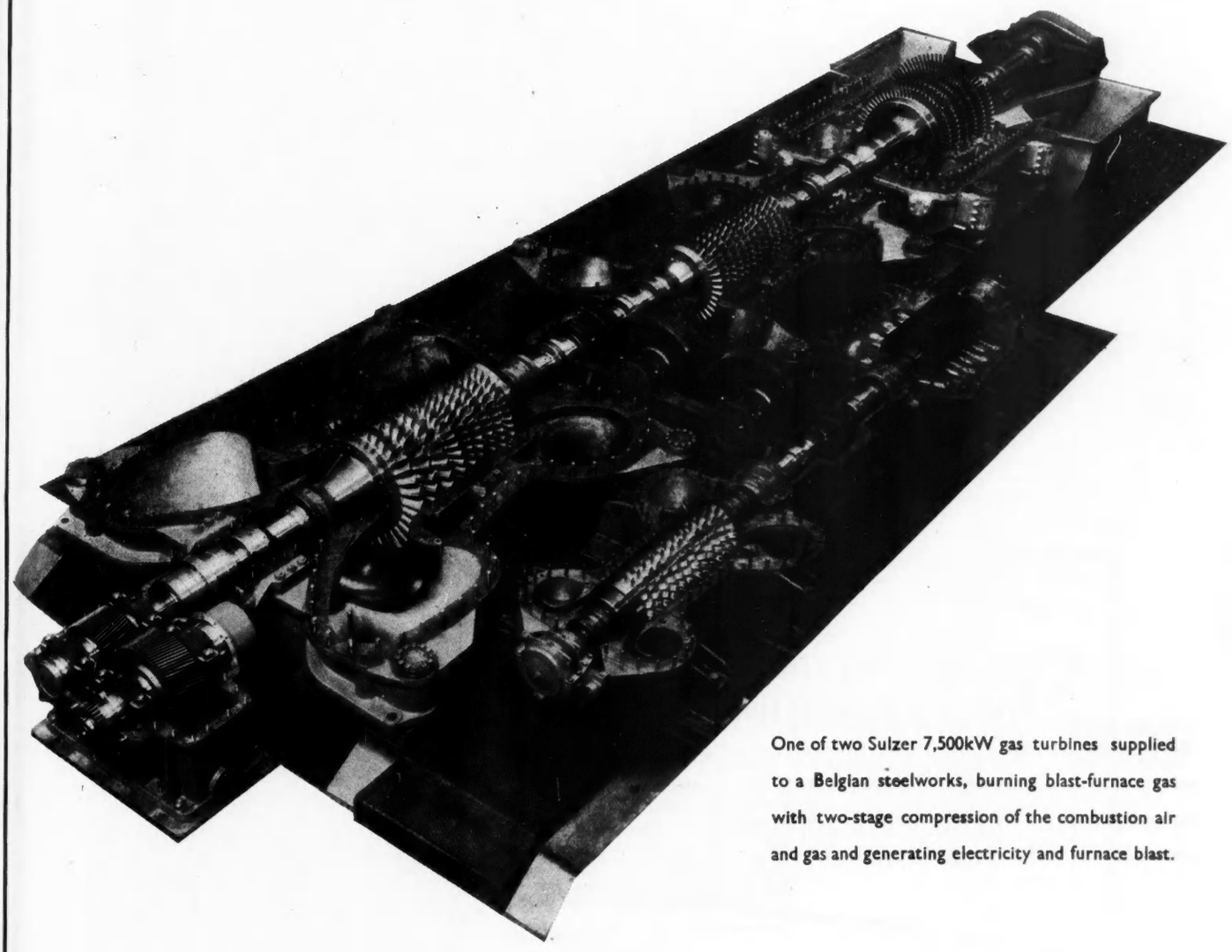

One of two Sulzer 7,500kW gas turbines supplied to a Belgian steelworks, burning blast-furnace gas with two-stage compression of the combustion air and gas and generating electricity and furnace blast.

HIGH EFFICIENCY · PRECISION CONSTRUCTION · ROBUST DESIGN

WIDE RANGE OF APPLICATION · SIMPLE REGULATION

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ADVANCING *with* Aeroflex

HOPE'S PATENTS

Photographed by courtesy of British Crepe Limited.

Fluvent Cubicle Type Switchboard recently supplied to British Crepe Ltd.

Fluvent Power Pillars—fully described in publication PP1, available on request.

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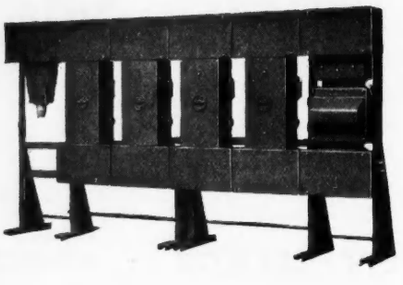
Energy Distribution for today's conditions demands fresh approaches. The examples illustrated are typical contributions by us to meet individual needs of widely different character.



Aeroflex Unit Type Switchboard, arranged so that any of the four outgoing circuits can be switched to either side of the busbars.

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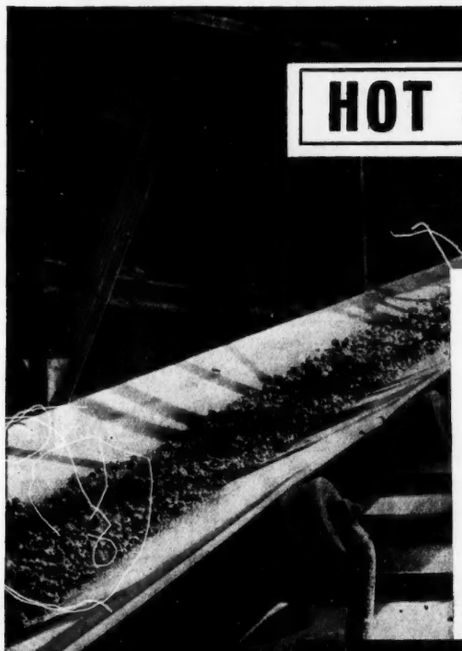


AT APPLEBY-FRODINGHAM STEEL WORKS

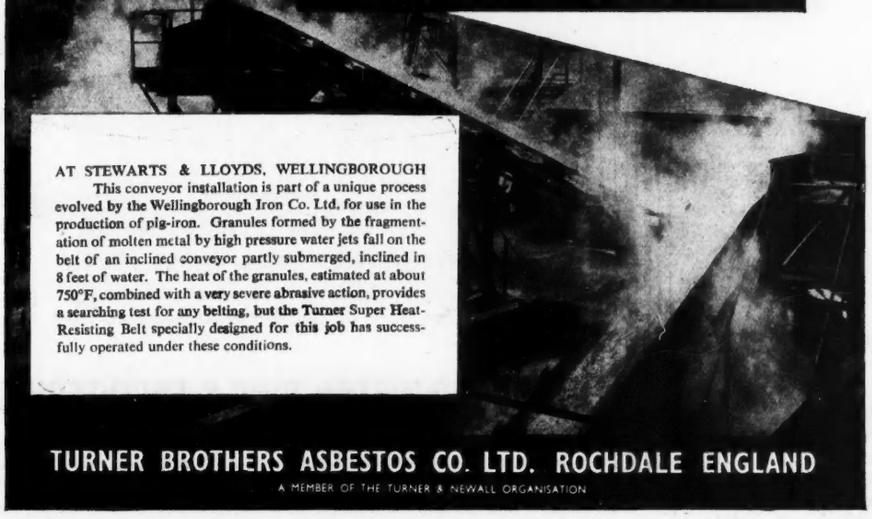
The conveyor belt shown above is one of five installed by us at the Appleby-Frodingham Steel Works where it handles 28,000 tons weekly of hot screened sinter at an estimated temperature at 650°F, operating 308 ft. centres and at a 7° gradient.

This Turner Super Heat-Resisting Belt, designed specially for this punishing work, has more than doubled the average belt life obtained previously.

If you have a hot conveying problem the advice of our technical staff is freely at your disposal.

(Photograph by courtesy of the Appleby-Frodingham Steel Company).

TURNERS
HEAT RESISTING CONVEYOR BELTING



AT STEWARTS & LLOYDS, WELLINGBOROUGH

This conveyor installation is part of a unique process evolved by the Wellingborough Iron Co. Ltd. for use in the production of pig-iron. Granules formed by the fragmentation of molten metal by high pressure water jets fall on the belt of an inclined conveyor partly submerged, inclined in 8 feet of water. The heat of the granules, estimated at about 750°F, combined with a very severe abrasive action, provides a searching test for any belting, but the Turner Super Heat-Resisting Belt specially designed for this job has successfully operated under these conditions.

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A MEMBER OF THE TURNER & NEWALL ORGANISATION

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that has won outstanding reputation throughout

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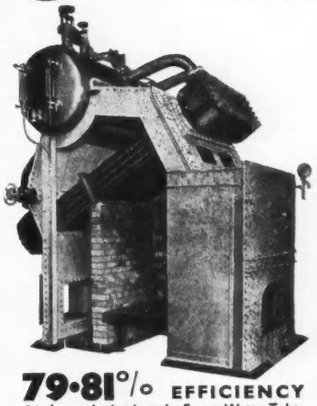

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FRASER WATER-TUBE BOILER

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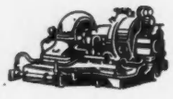

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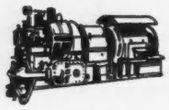

Turbine driven up to 11,000 KW.
Engine driven up to 340 KW.
Scores in hand, hundreds in service.

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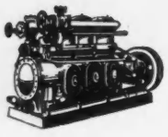

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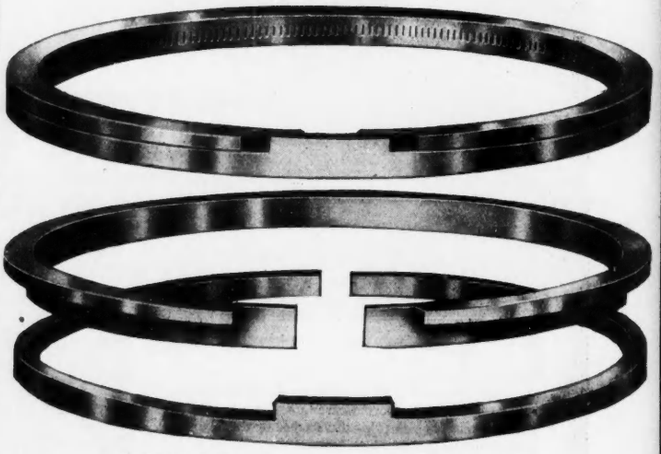

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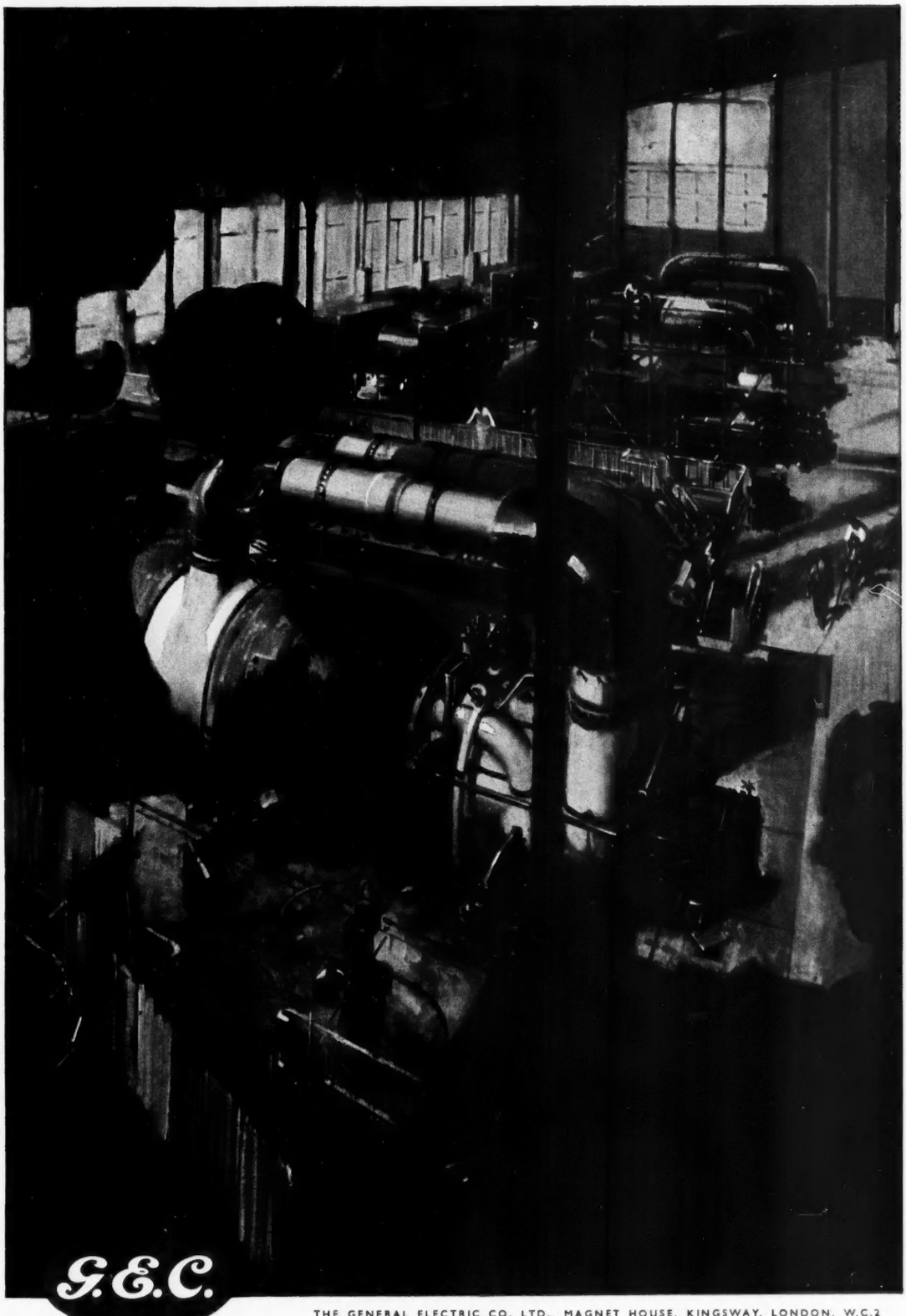

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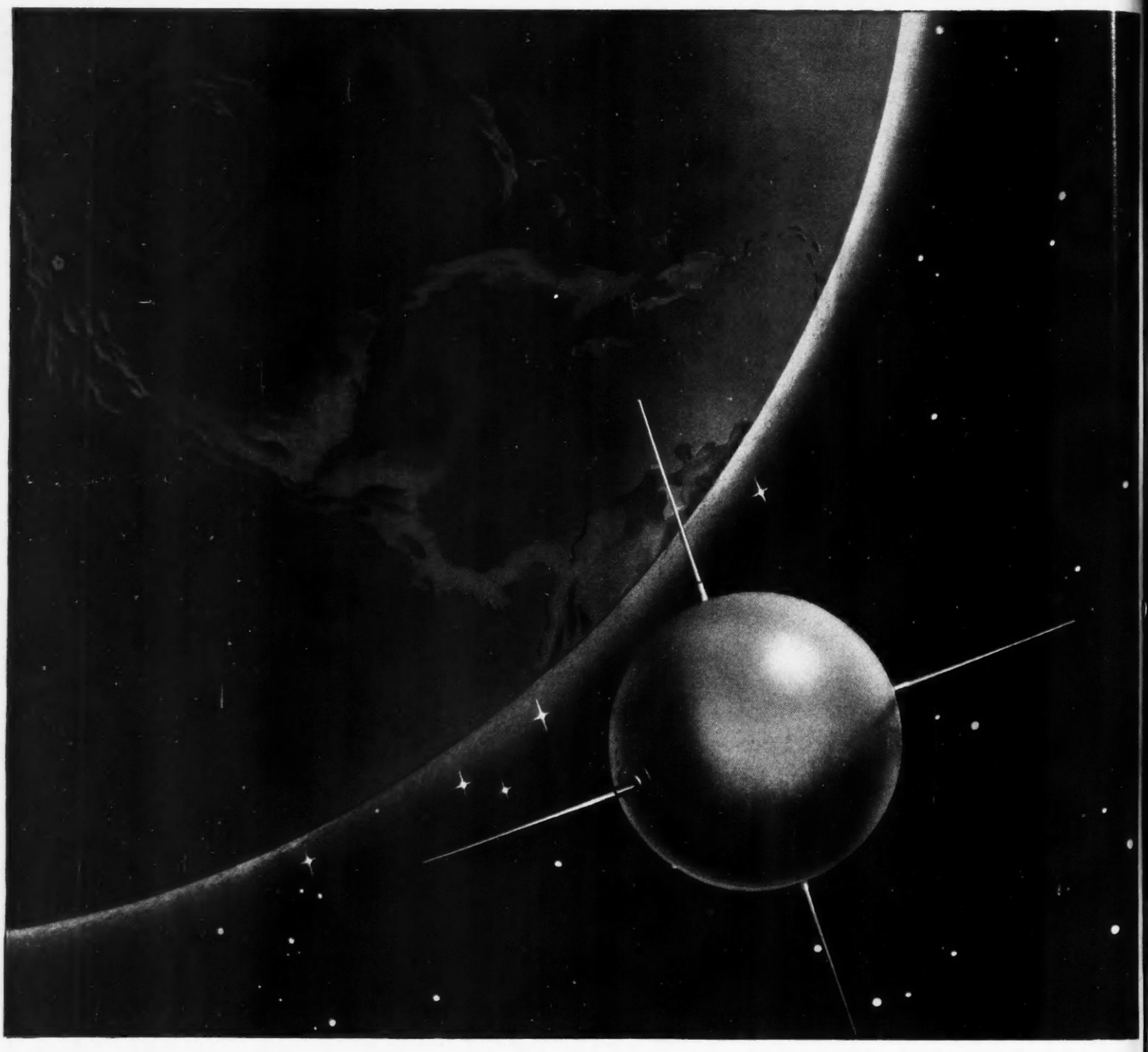

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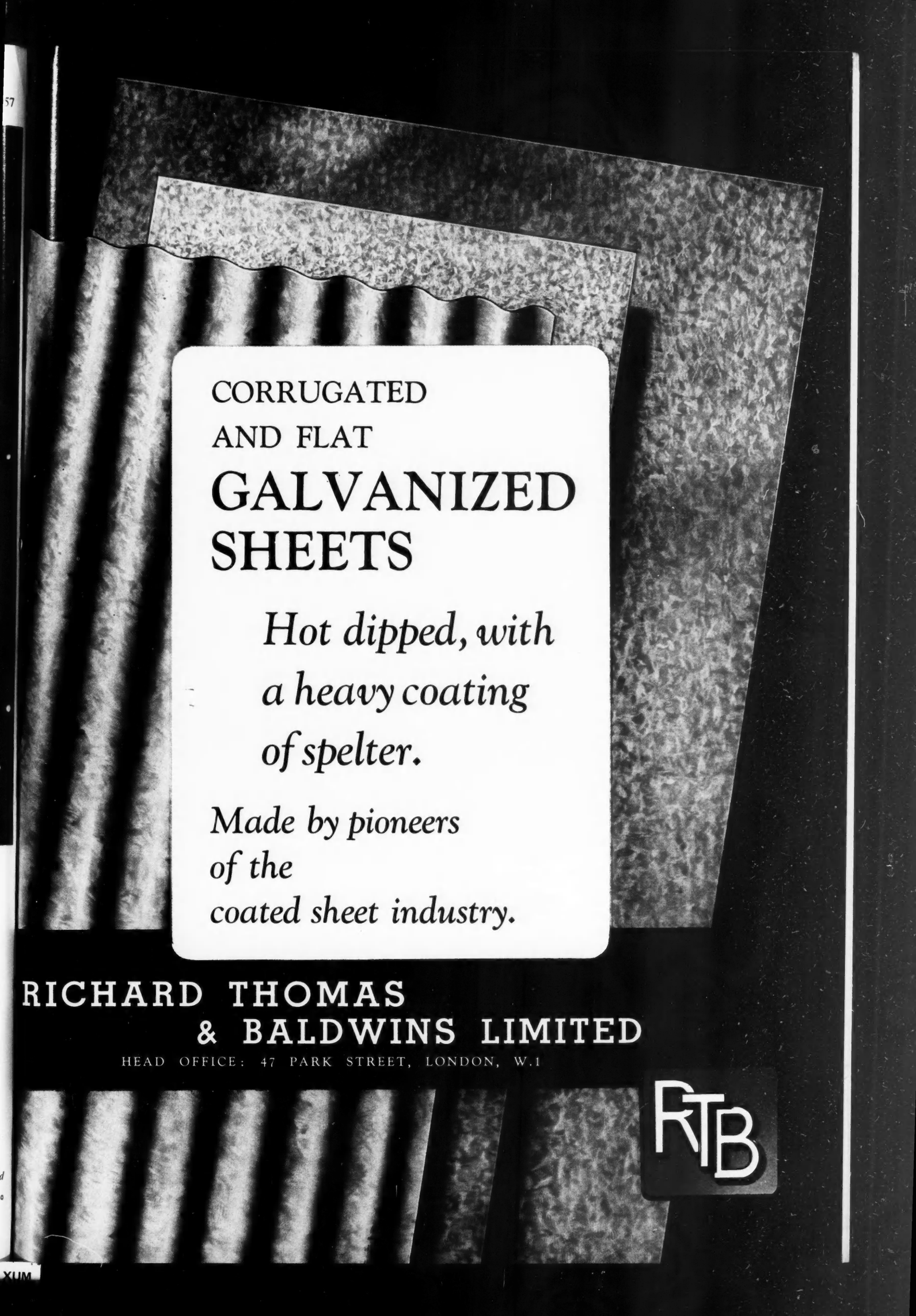
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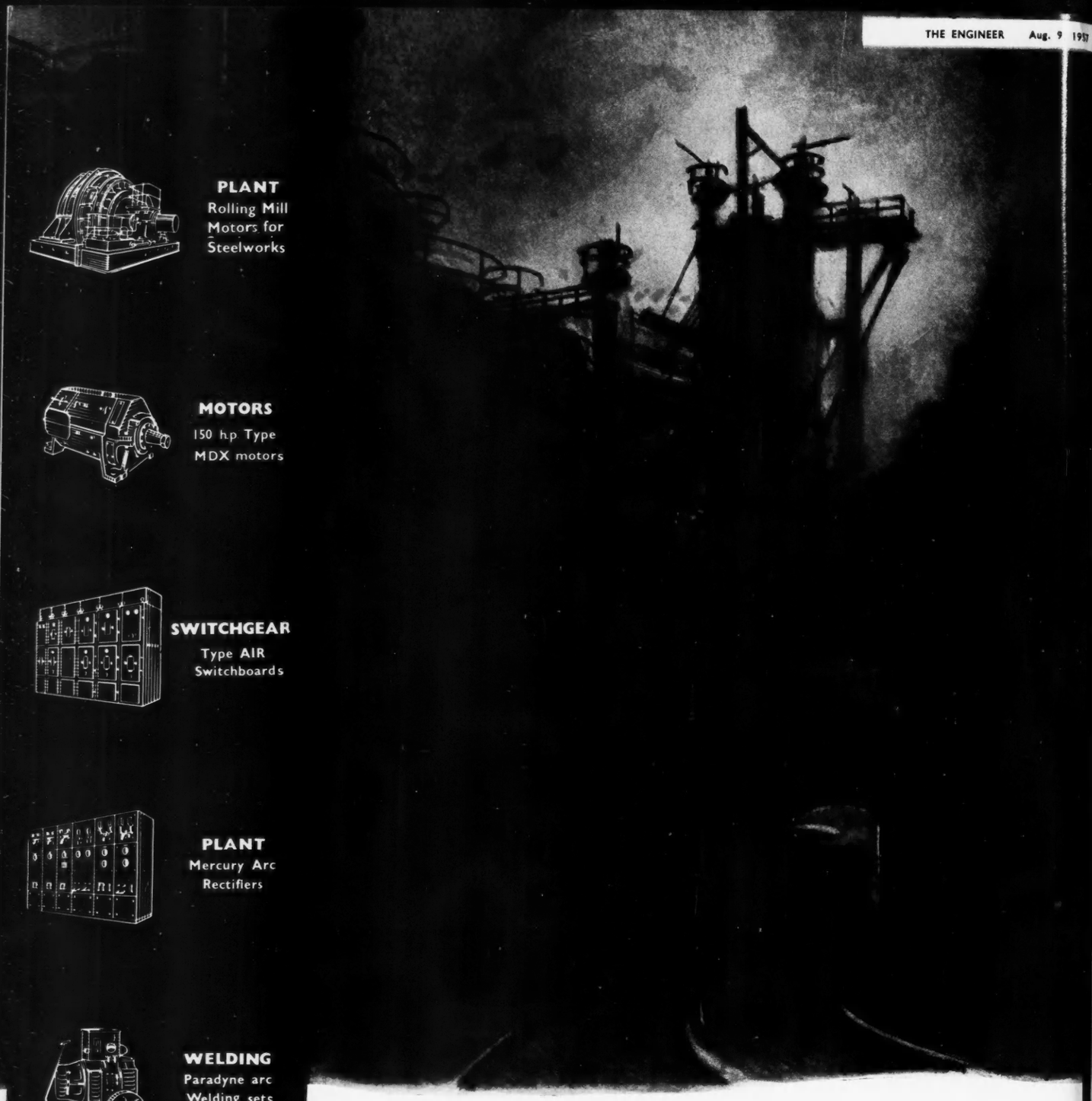

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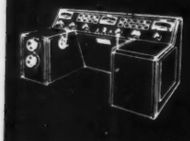

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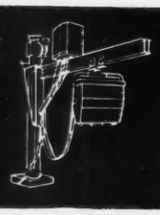

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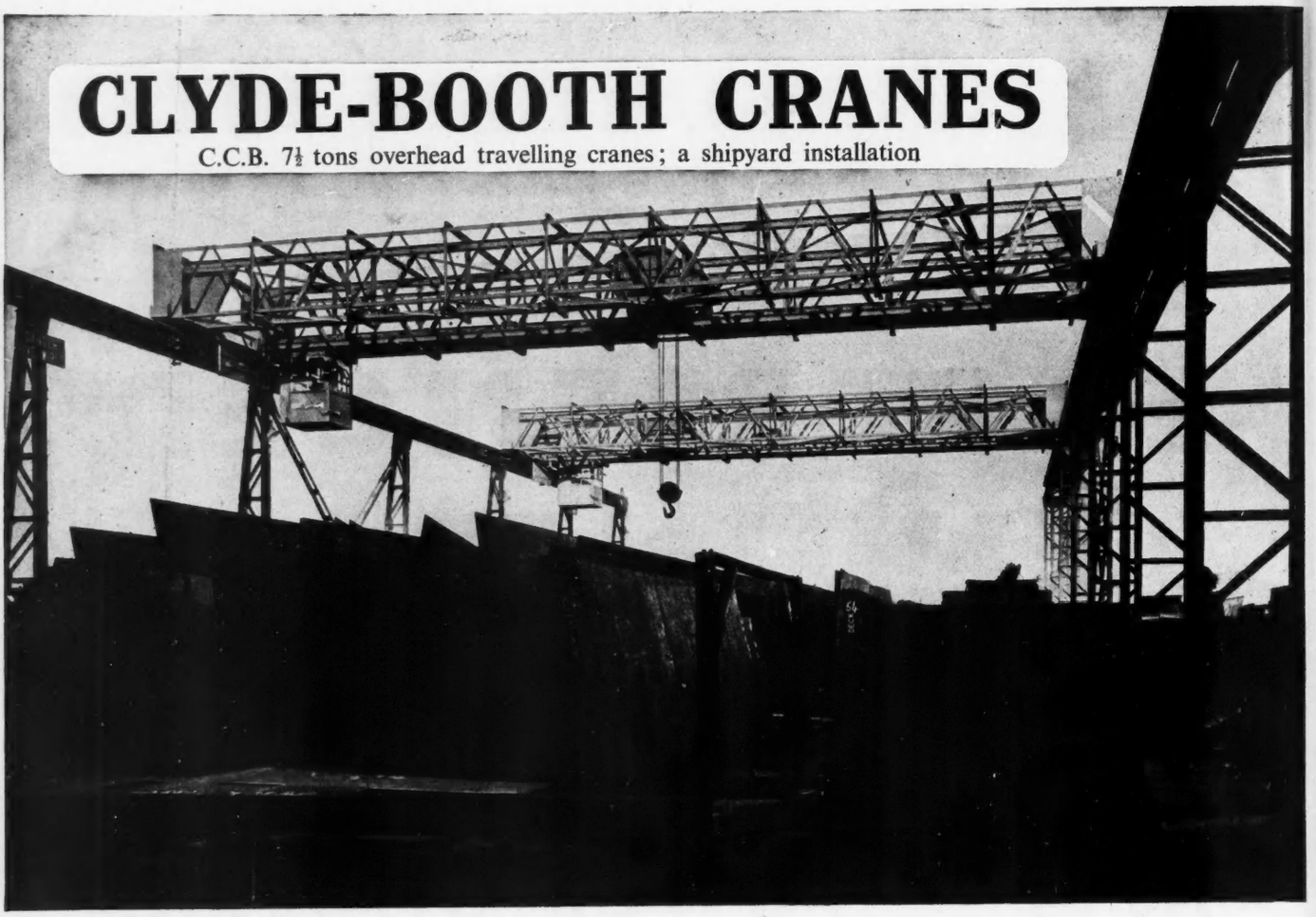

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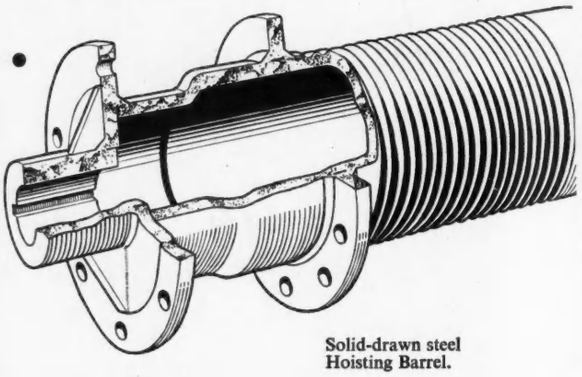

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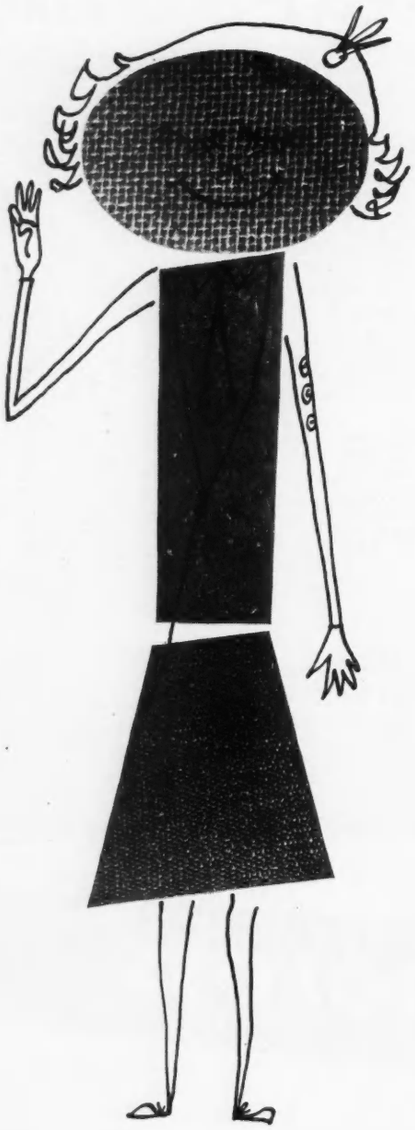

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good electrical resistance
high dimensional stability
low coefficient of friction

Ferobestos can be supplied from stock in sheets, rods and tubes. Special mouldings, where quantity justifies the cost, can be made to order. Write for fully detailed and illustrated leaflets.

The versatility of Ferobestos, an asbestos-reinforced plastic material, opens up an extremely wide range of engineering applications.
As well as guides these include:—

Bushes
Coupling Discs
Bearings
Gears and Rollers
Piston Rings
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Mounting Pads
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Ferobestos is available in a number of special grades including silicone impregnated for greater heat resistance and graphite impregnated for more efficient lubrication.

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FEROBESTOS DEPARTMENT

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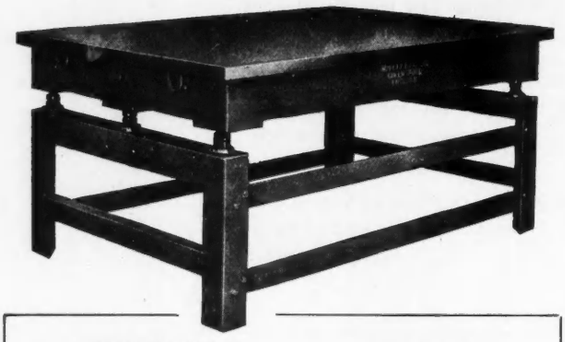

GRADE 'A'
Hand scraped and surfaced to within 0.0001 in.—0.003 in. from a mean true plane over whole surface according to size.

GRADE 'B'
Smooth planed finish accurate to 0.001 in.—0.003 in. according to size.

Sizes up to 4'0" x 2'0" have three-point support
Sizes 4'0" x 3'0" to 6'0" x 4'0" have five-point adjustable support. 8' x 3' to 12' x 6' have six-point adjustable support.
Our grade 'A' tables conform to B.S.S. 817-1938 in all respects.

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CROWN WORKS, CHELMSFORD
ENGLAND
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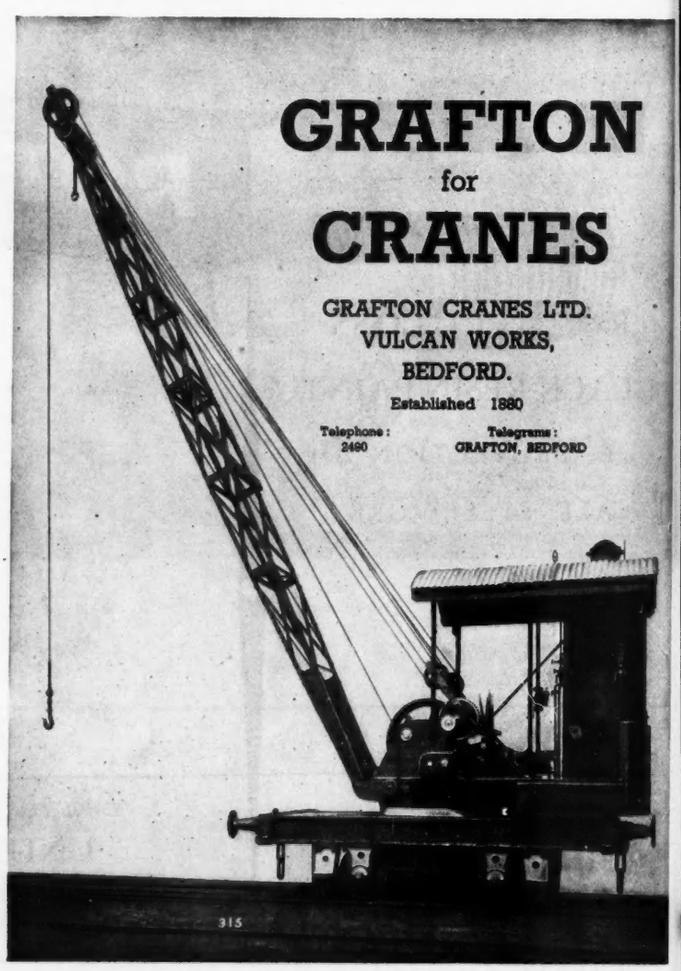

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Azoflex Model E.50

brings A·U·T·O·M·A·T·I·O·N · · · ·

to the Drawing Office

the only machine that prints, develops and delivers the standard 10″ × 15″ drawing office sheet at up to 1,200 copies per hour.

See it on Stand No. 4 BB, Empire Hall, 1st Floor, at the Engineering, Marine, Welding and Nuclear Energy Exhibition, Olympia, August 29th — September 12th.

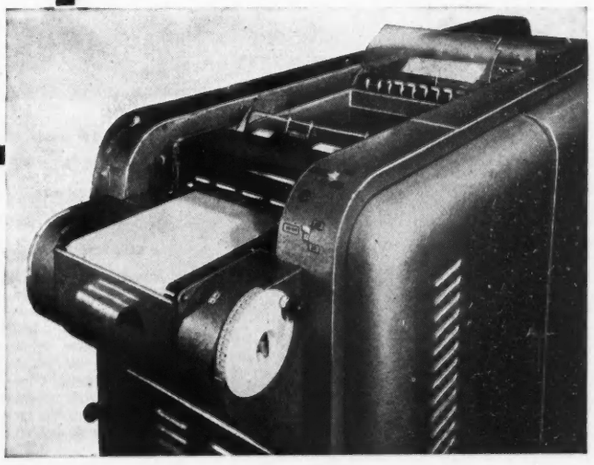
A single operator can handle the machine which automatically cuts, counts, develops, prints and stacks as many copies as required with the master copy remaining in the same condition as when it went into the machine.

It requires no darkroom; there are no unpleasant fumes and it takes up relatively little space.

Used continuously it will pay for itself by the economy in material cost alone, due to its ability to work from roll material rather than cut sheets.

The unique Azoflex range of diazo materials, developed by Ilford, enables the Model E.50 to be used for the reproduction of opaque and double-sided originals, in addition to standard drawing office translucent masters. The Model E.50 is only one of the range of Azoflex machines designed to assist and provide economies in modern drawing office reproduction practice. For details of the full range of Azoflex machines and materials write or telephone:

Ilford Limited,
Azoflex Sales Department, AZ12H,
104 High Holborn, London, W.C.1
Telephone: HOLborn 3401



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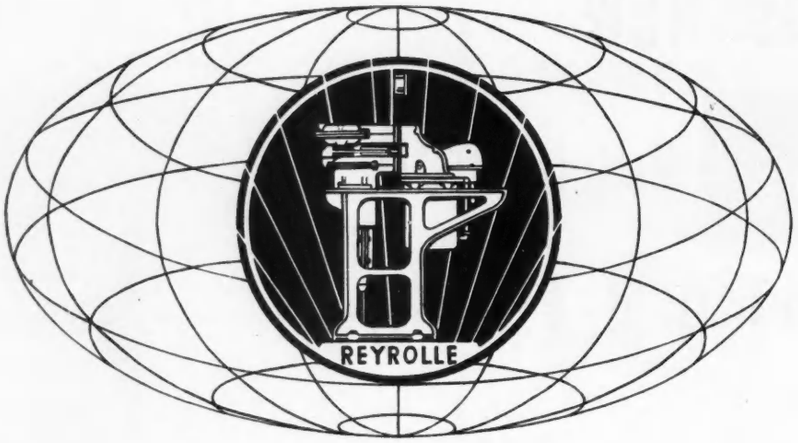

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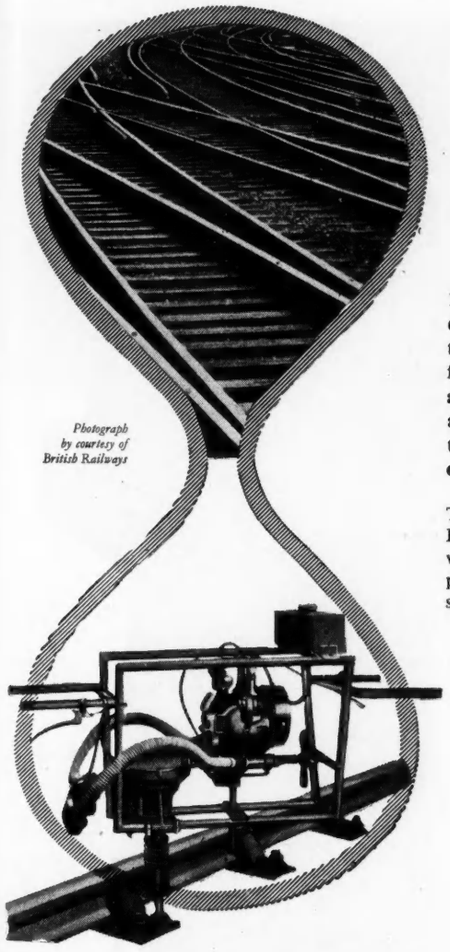

Photograph by courtesy of British Railways

Is this a good hour's work for sixpence?

120 HOLES BORED and 120 coach screws driven home in every hour's work—with only two men and a daily operating cost of only a few shillings. The John Bull Coach Screwing and Sleeper Boring Equipment bores through any sleeper in 4 to 10 seconds, according to thickness, and drives home a coach screw to the exact tightness required in the same time.

THE ADVICE OF SEVERAL RAILWAY ENGINEERS of British Railways was taken in the design of the versatile John Bull power unit. This is a portable, petrol-driven, completely self-contained power-source. With its four easily fitted and changed attachments it adds speed, efficiency, and economy to a wide variety of track maintenance operations.

IN JUST A FEW MINUTES the Coach Screwing and Sleeper Boring attachment can be fitted and ready for use. Strength and lightness are well combined in this equipment: constructed of high grade steel and light alloys the whole unit weighs only 110 lbs. and can be carried and operated easily and constantly by only two men. The operators' safety is guaranteed by the enclosing of all moving parts within the lightweight, but robust, tubular frame. The special adjustable slipping clutch eliminates the risk of over-tightening and of bursting the wooden ferrules.

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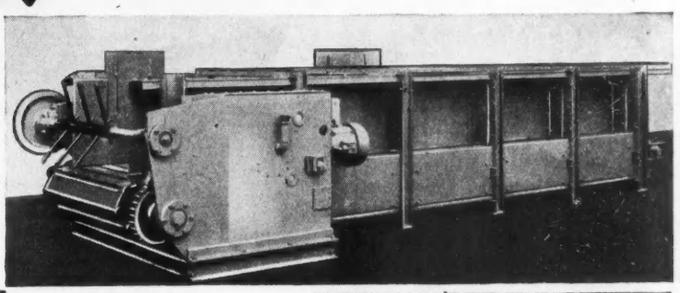
IVO NEW, FULLY HYDRAULICALLY OPERATED BOX-FEEDER

FOR THE REGULAR AND CONSISTENT FEEDING OF ONE OR MORE CLAYS, SHALES, SAND, COKE ETC. IN CONTROLLED AND PROPORTIONATE AMOUNTS.

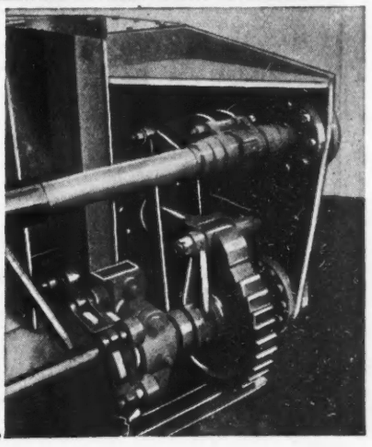


The IVO Hydraulic Box Feeder has a rectangular hopper with as many adjustable gates as required. Its sides are tapering towards the top and rear. A very substantial slatted steel conveyor supported on 3 rollers over its width forms the bottom. This conveyor is propelled by means of a ratchet drive. The driving pawl being attached to the end of a hydraulic ram, the stroke speed of which is readily adjustable by means of a simple hydraulic control lever.

A mixing shaft with prickers or knives is provided at the output end and this is also operated by means of double-acting hydraulic ram. The whole of the hydraulic driving gear and its electric motor are entirely dust and weatherproof and self contained. Damage or breakage of the conveyor or other moving parts is impossible since in the event of an overload or jamming, the pressure release valve will lift and unload the hydraulic system and the conveyor etc. will stop till the jam or obstruction has been cleared.

Hopper sizes from 15' to 30' x 4' x 2' 6' approx; hourly feed capacities, infinitely variable from nothing - 30 cubic yards per hour.

The purpose of this machine is to provide under most arduous conditions a regular and reliable feed of one or more materials to the processing machines of the heavy clay, ceramic, cement and many other industries.



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Telephone: SHEpherds Bush 4382/5 (4 lines).

Individual machine applications

Two small Model 70A (assembled) Self-contained Dust Collector Units, complete with exhaust fans and power operated tube shaking mechanism.
These collectors are in operation at Messrs. High Duty Alloys Ltd., Redditch.

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XUM

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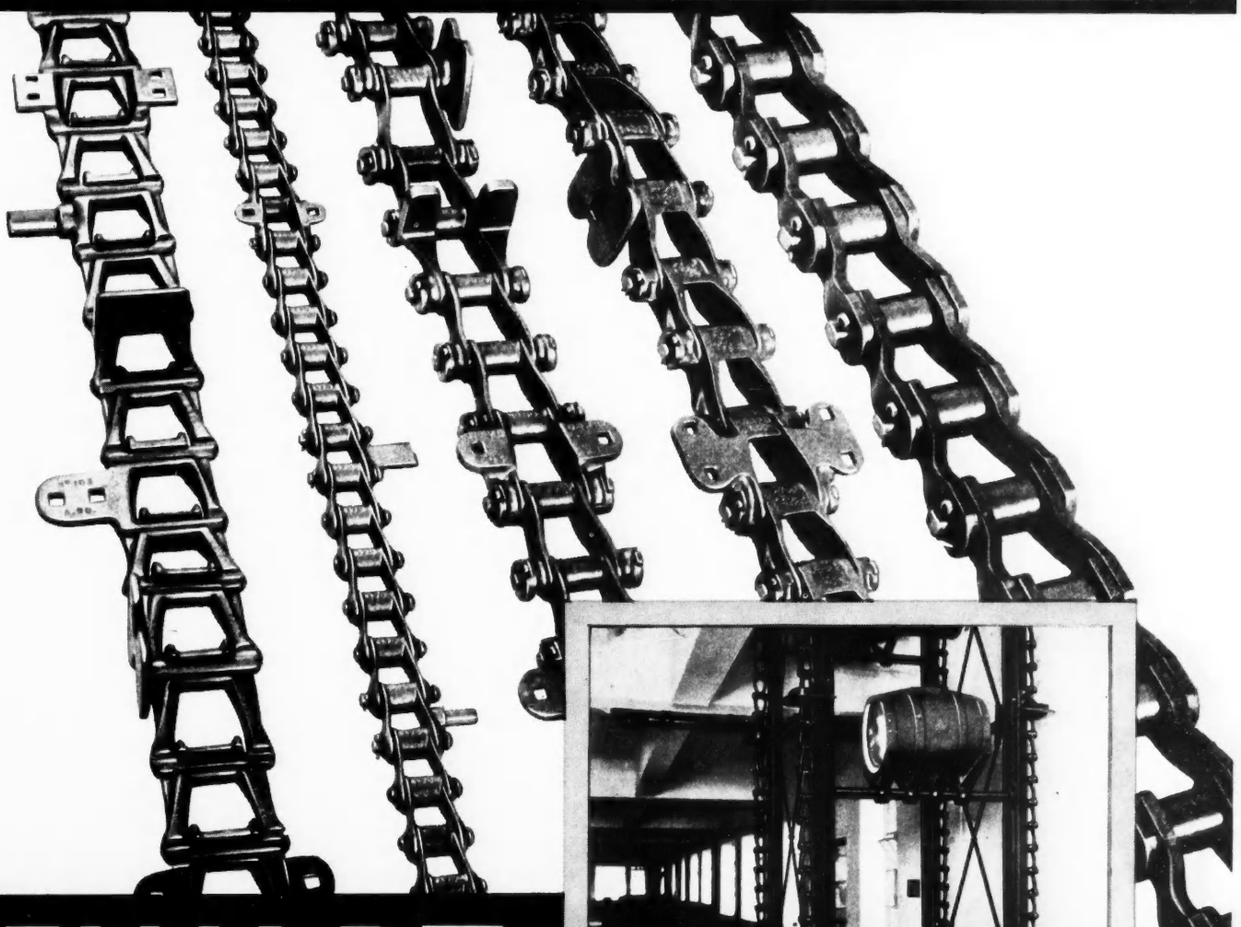

Swing Tray Elevator serving three floors

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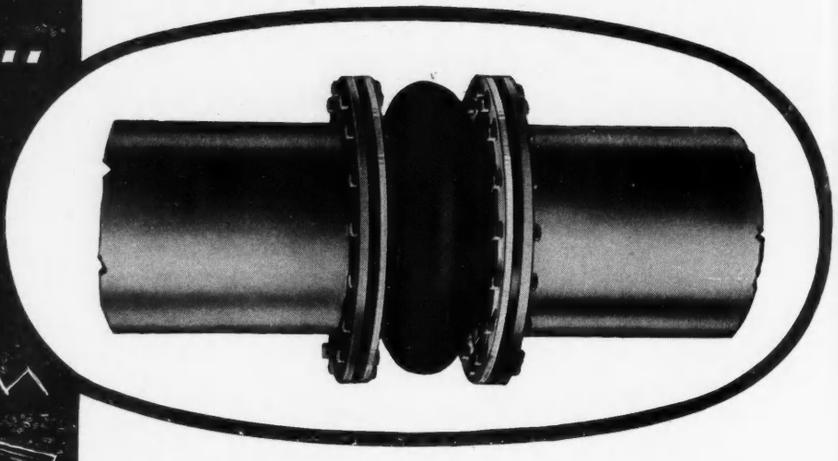

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The installation of Andre rubber expansion pieces in main circulating pipes completely eliminates stresses and strains set up by linear expansion and contraction due to temperature changes. In addition they absorb destructive vibration, reduce the transmission of noise, compensate for misalignment and protect against damage from shock.

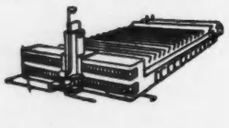
Andre expansion pieces are designed to accommodate working pressures up to 150 p.s.i. depending on size. They are also suitable for conditions of complete vacuum.

They are available in a range of sizes from 2-60 ins. diameter for use with British and American standard pipework. Flexible faring pieces and fireguards are also available.

Andre Rubber Expansion Pieces are suitable for:

- Sea water.
- Mineral and vegetable oil.
- Weak mineral acids.
- Caustic and other alkali solutions.
- Some organic acids.
- Many other chemicals.
- Hot air.
- Corrosive gases at temperatures between minus 35°C and plus 100°C.

Three-and-a-half Acres of Specialised Rubber Technology



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'Kynal' treadplate installed in the Hull factory of Premier Oil and Cake Mills Ltd. Contractors : Messrs. Brogden and Wilson Ltd., Scarborough.

'Kynal' aluminium alloy treadplate combines a pleasing appearance with durability and lightness. Its safe non-slip surface is so constructed that liquids drain rapidly away and —an important point where the entire flooring consists of treadplate—is designed for maximum foot comfort. With 'Kynal' treadplate, I.C.I. Metals Division puts you on a firm footing in factories or public buildings, on engine room floorings, catwalks, manhole covers, steps, kick-plates, elevated gang-ways and overhead crane platforms.

'KYNAL' TREADPLATE

Made by specialists in aluminium for specialists in construction

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At our works near Swansea we undertake a complete range of sheet metal work including press-work, assembly and welding, backed by the design and manufacture of press-tools and jigs.

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We are fully equipped to undertake large scale development work and manufacture, and invite enquiries

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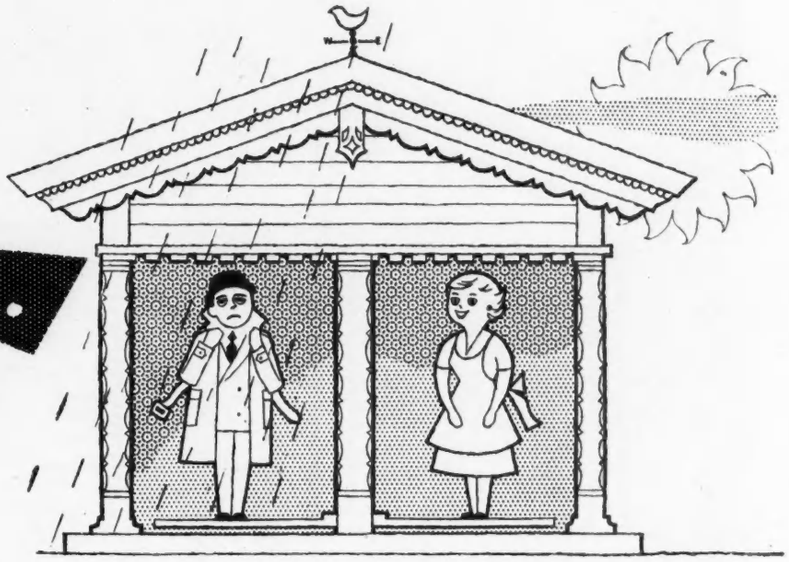
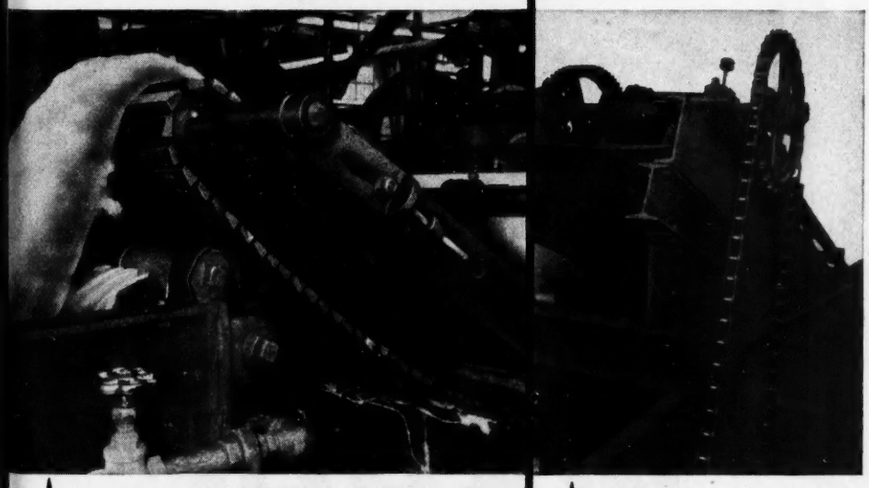
hot or cold



FIT THE COVENTRY MARK 5

steel roller chains as a replacement for malleable chains on slow speed drives and light conveyors on all kinds of machinery and plant where operating conditions are bad and the chains are not enclosed.

Write for Catalogue Ref. 116/101 for full details, dimensions and prices.



In continuous contact with wool saturated in cleaning fluid, containing waste from previous washings, The Coventry Mark 5 chain on this wash-bowl carrier is still giving trouble-free service after over three years' continuous service.

Working without lubrication and covered in coke dust, The Coventry Mark 5 chain on this conveyor headstock drive continually handles 90 tons of coke per day.

★ runs easier

★ lasts longer

★ works better

whatever the weather it's a fine chain!

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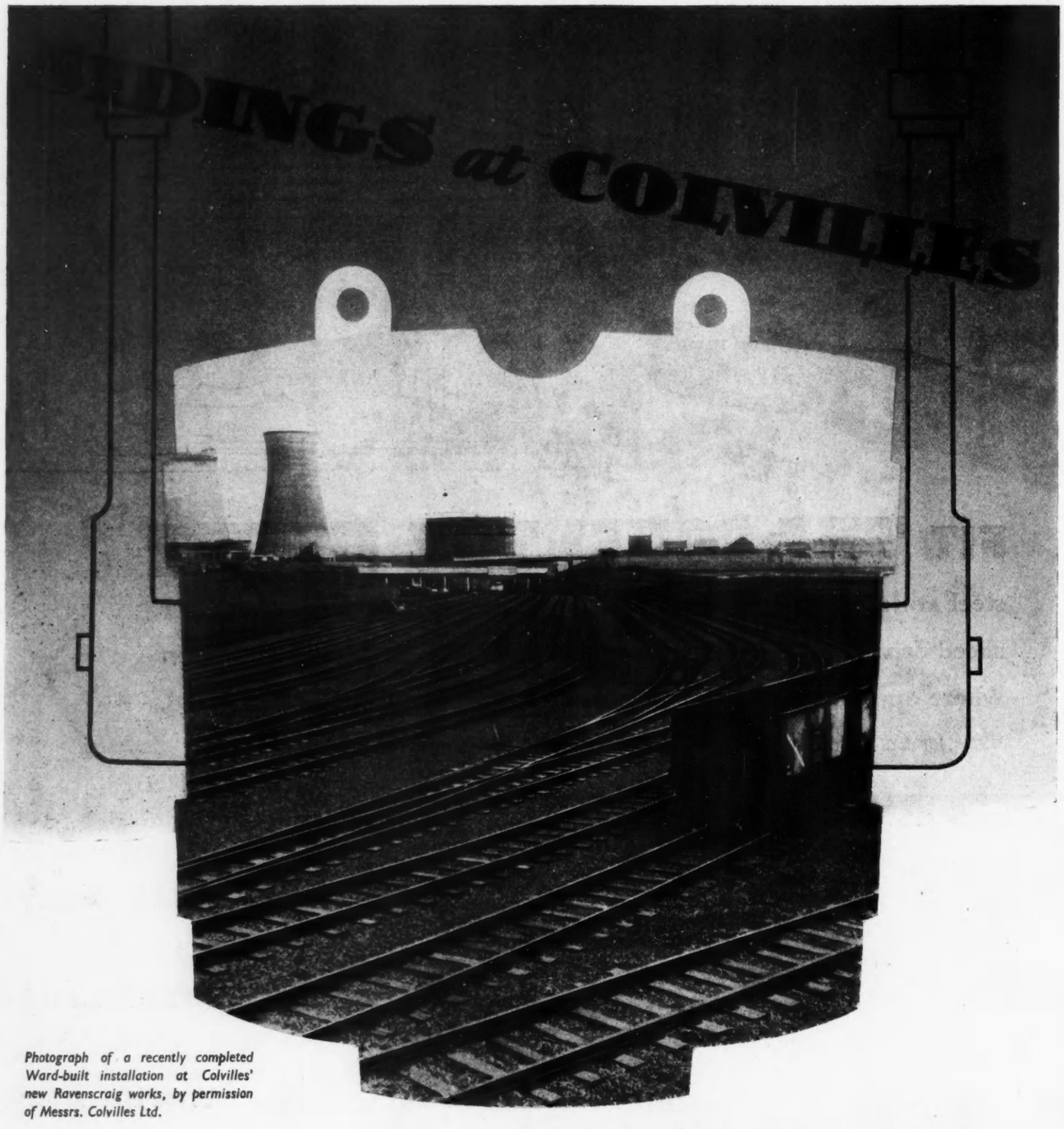

Photograph of a recently completed Ward-built installation at Colvilles' new Ravenscraig works, by permission of Messrs. Colvilles Ltd.

By WARDS

For over 60 years Wards have been building sidings. Backed by the resources of the WARD group of companies, Rail Department's facilities enable the carrying out of contracts of all sizes simultaneously, irrespective of location.

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Stoker rental Scheme available

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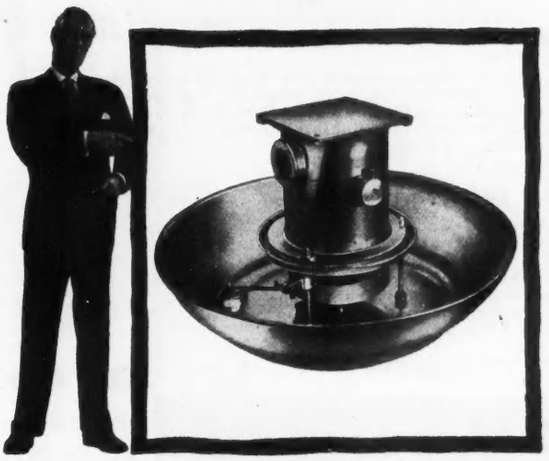

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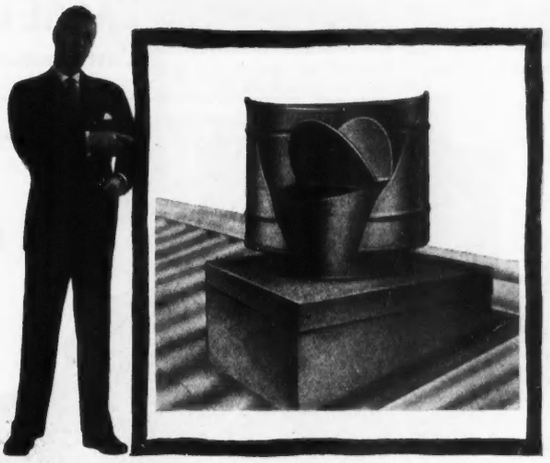
—a new humidifier which has already proved of immense value to many industries from Textiles to Tobacco. The Aerosol-Turbo gives trouble-free, controlled humidification, without wetting or water tracking. May we demonstrate this machine at your premises?



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From the top of the newly constructed Coal preparation plant: a small section of the immense network of railway sidings.

The supply and installation of these sidings and the adjoining trackwork for the new Coal Carbonization and Benzole Rectification Schemes were entrusted to the Eagre Construction Co., Ltd., by the National Coal Board. Over 9,000 tons of Iron and Steel were used in the construction of the forty miles of track and 230 turnouts and Special Point and Crossing layouts comprising the combined railway Sidings.

Eagre's skilful planning and practical experience in the day-to-day working of Colliery Sidings ensured that this vast scheme was laid efficiently to schedule, and without the slightest interruption of existing Colliery traffic.

Photograph by courtesy of National Coal Board

WORK BEGINS AT CADEBY:

The National Coal Board again entrusts the Eagre Construction Co. Ltd. with a similar project. Earthworks, Drainage, Track Laying and ancillary works for thirteen miles of Sidings are now in progress at Cadeby Main.

Photograph by courtesy of National Coal Board

for a complete Track Service

In addition to its activities in the Nation's Coalfields, the Eagre Construction Co. Ltd. has worked continuously during the past ten years for British Railways, the Gas Board, the United Steel Companies, and has carried out large Power Station Projects for the Central Electricity Authority.

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DESIGN
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Whatever the magnitude of your siding requirements, be sure to consult

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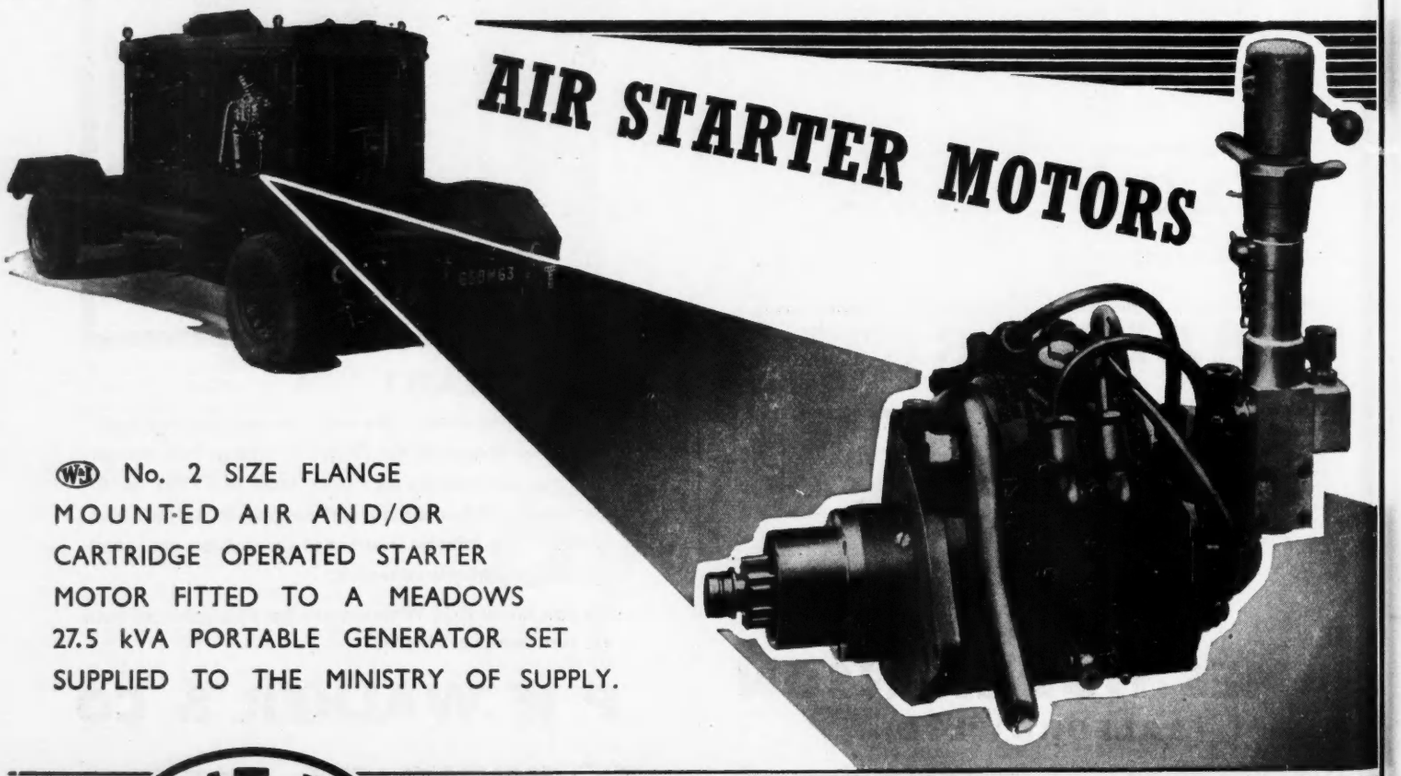
East Common Lane SCUNTHORPE Lincs. Telephone: Scunthorpe 4513

EAGRE



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W&J No. 2 SIZE FLANGE MOUNTED AIR AND/OR CARTRIDGE OPERATED STARTER MOTOR FITTED TO A MEADOWS 27.5 kVA PORTABLE GENERATOR SET SUPPLIED TO THE MINISTRY OF SUPPLY.

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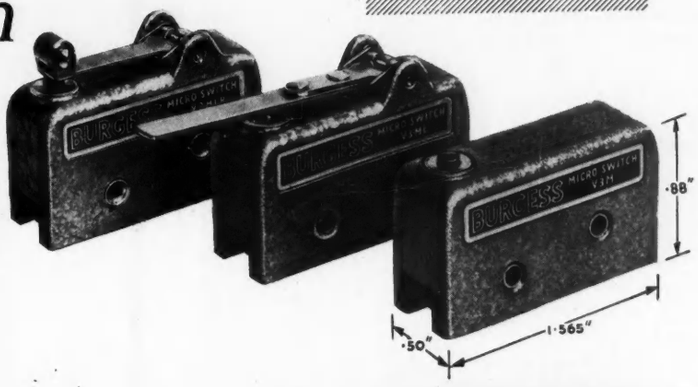

The V3M range of Metalclad Miniature Micro Switches by

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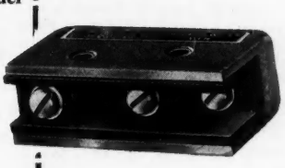
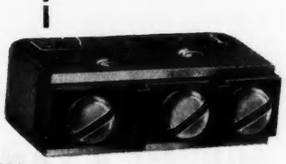
THE BRITISH SPECIALISTS

Details in Folder MS21/14





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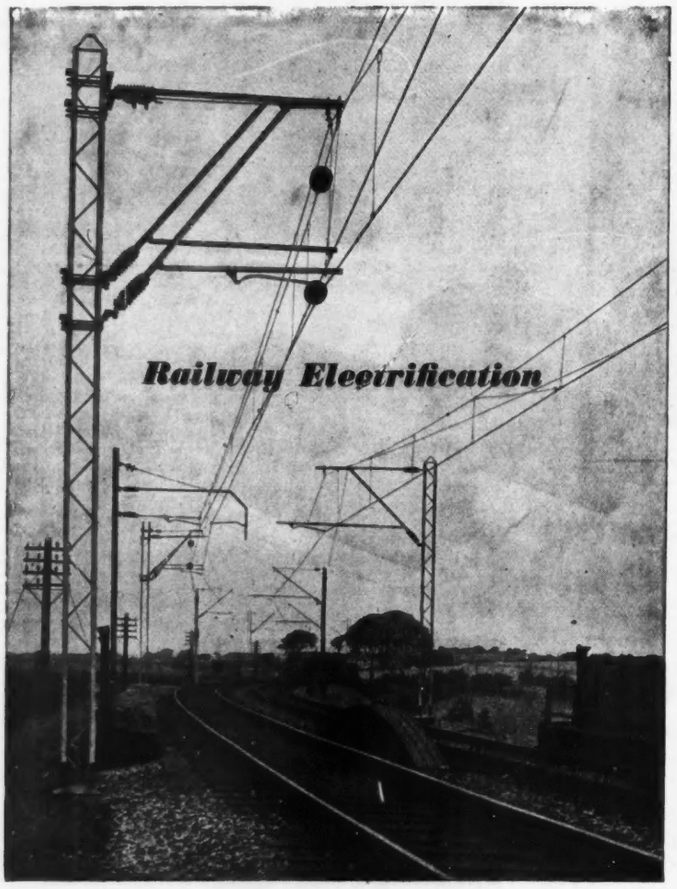

One of the latest of the many railway electrification schemes
(Conductor Rail and Overhead Systems)
for which Bullers have supplied insulators and fittings
during the past 50 years.

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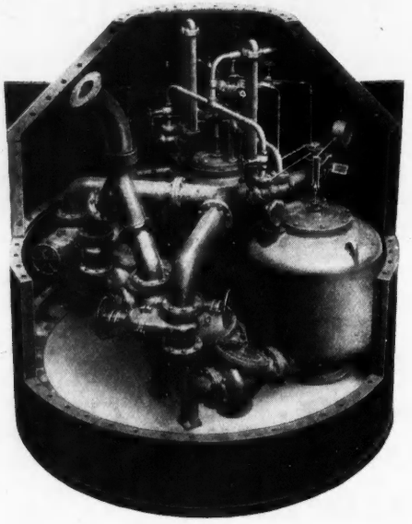
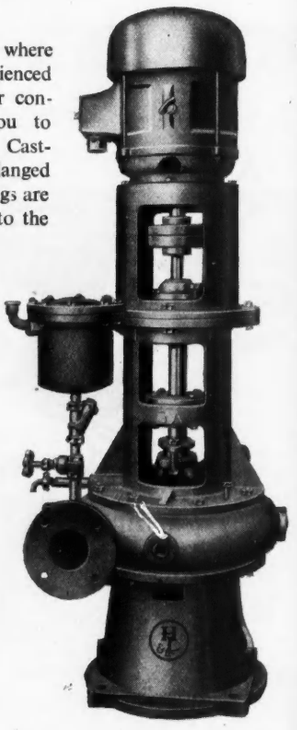
London Office: 6 LAURENCE POUNTNEY HILL, E.C.4 *Phone: MANsion House 9971*

"SHONE" EJECTORS in Cast-Iron Tubbing



In bad or waterlogged ground where great difficulty would be experienced in securing a watertight brick or concrete chamber, it will pay you to specify "SHONE" Ejectors in Cast-Iron Tubbings. Consisting of flanged plates bolted together the tubbings are watertight and give easy access to the Ejectors for inspection.



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VERTICAL TYPE

Any matter which can enter the suction pipe will be passed through the pump without fear of clogging or choking or of the use of knives or cutters. The impeller has two balanced full-way passages and in motor driven vertical pumps the impeller can be dismantled without disturbing the motor. Available in horizontal or vertical types for any kind of drive.

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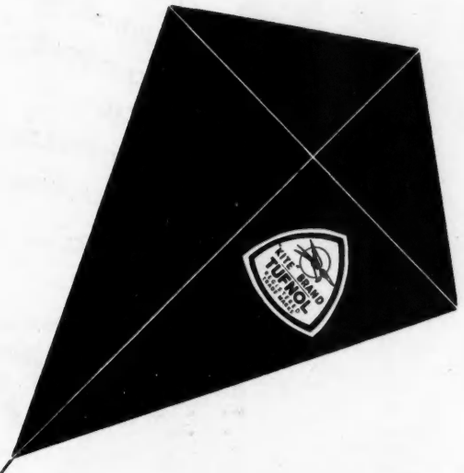

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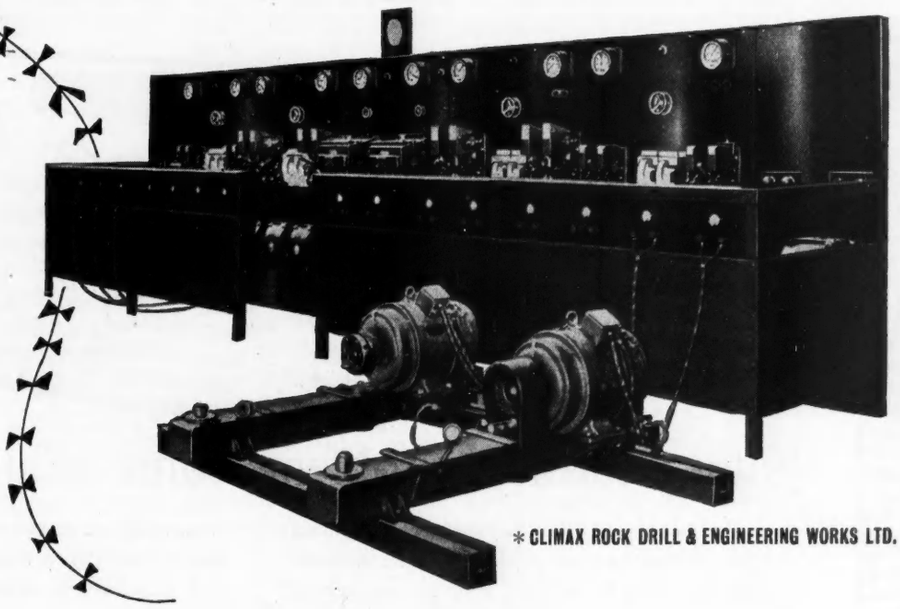

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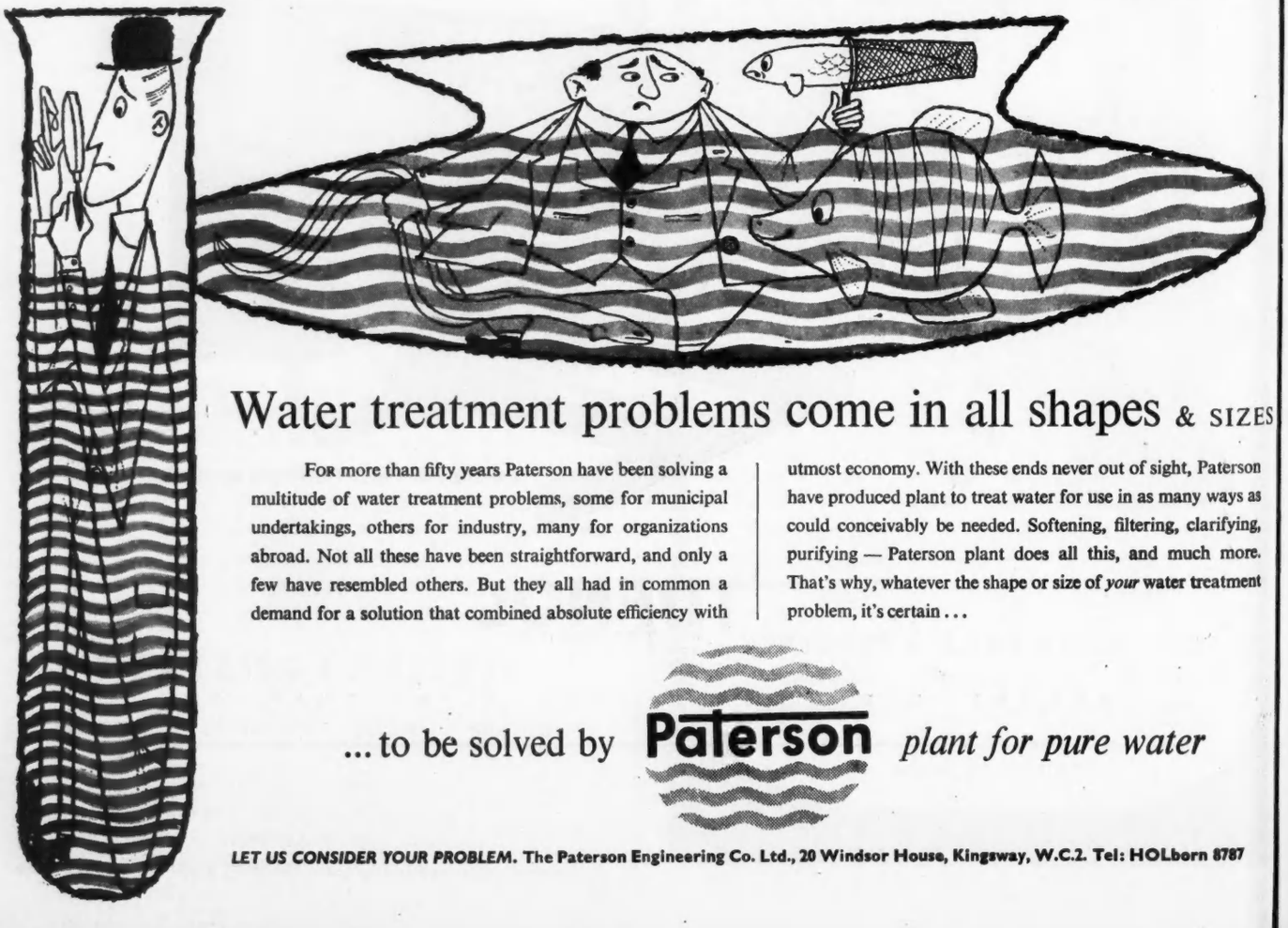

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THE ENGINEER

VOL. 204 No. 5298 AUGUST 9, 1957

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ANSWERS AND QUESTIONS AT LONDON AIRPORT

The committee of officers of the Ministry of Transport and Civil Aviation, of the Air Ministry, and of the airline corporations which, between October, 1955 and April last, considered the development of London Airport, has confined itself mainly to the particular questions listed in its terms of reference. It recommends principally that the passenger handling still taking place in the North terminal be transferred to the central area, that the passenger buildings have "fingers" to give covered access to parked aircraft, and that one and, possibly, both the existing NW/SE runways be abandoned to allow extension of the centre. These recommendations are no more than consistent with the original wise decision to site the buildings within the runways. This arrangement minimises taxying, an advantage dear to the jet aircraft, and it is only reasonable to arrange the buildings to obviate the "so near and yet so far" gap which the passenger has to cross by bus to reach the apron. The committee's study of the runway requirements is engrossing, and affords an enlightening example of the changed demands upon aerodrome layout resulting from advanced aircraft performance. By raising the tolerable crosswind component to 18 knots, instead of the 10 regarded as the maximum permissible by the original Advisory Layout Panel, an availability of 99·86 per cent can be envisaged with only two runway directions! It is tempting to wish that the introduction of advanced aircraft had proceeded swiftly enough for the possibility of reaching the I.C.A.O. recommended usability of 95 per cent without a pair of runways in the NW/SE direction before the original R.A.F. runway of this orientation was covered by the central buildings and replaced by the existing pair. While a convincing case has now been established for the withdrawal of the new 5823ft runway No. 4, we cannot but question the wisdom of the suggestion that runway No. 6 might also be abandoned. For the increased permissible crosswinds mean that the occasions on which a NW/SE runway would be conveniently usable have increased even though those on which it must be used have decreased; and a 7570ft by 300ft runway is not lightly to be discarded by even the best endowed airport! It is somewhat surprising that the committee, recalling the discussion by the Layout Panel of tangential schemes, did not consider extending NE/SW runway No. 7, across the Duke of Northumberland's River, towards Stanwell Place, to allow that part of it which contributes to the hexagon surrounding the central area to be closed. The existing length of 6260ft could probably be recovered by such an extension, while the closed part would usually be at the starting, not the stopping, end; by comparison with the proposals for No. 4 it can be seen that the "closed" end would become a taxyway rather than an aircraft stand, and could presumably be held clear for an emergency.

That the deliberations of the committee were so circumscribed is, no doubt, to be traced to the fact that, in its judgment, the air traffic control problem preponderates over all others. Because the committee visualises no more than forty landings and forty departures in a peak hour, it finds no need to discuss the fact that propeller-driven machines will want to turn off after a fraction of the landing run of a jet, or that the jet will demand clearance to take off with no delay once it has started its engines. These and many other factors must be under consideration by the Minister of Transport and Civil Aviation, whose greatest problem in this context is the future international fare structure. The issue facing the International Air Transport Association is whether the customer shall pay a higher price for higher speed, or whether propeller and jet aircraft shall levy the same fares for the same class of transport. The nations of the Old World, having already built turbo-prop machines, will naturally strive for an opportunity to sell their seats in competition with the faster and (internally) quieter jet airliners from the New World. Just one of the many issues pending on the eventual decision is seen here; if no differential is introduced, British European Airways might be forced to fly such machines as the "Comet," despite Lord Douglas's exposition of the economic superiority of the turbo-prop and the widespread objection to the noise of jet engines, with the result that the runway requirement, in terms both of length and time occupied, would be raised severely.

The Minister must also be aware that the term "London Airport" is liable to mislead. With the reduced need to land at, say, Gander, and the increased demand for expensive ground facilities, there will be a trend for the airport to become the terminal for all Britain. This is a development that has already exerted its influence. It is a curious anomaly that the adoption of an aerodrome able to handle the heaviest aircraft has resulted in the journey from the centre of London to the centre of

Paris being no quicker now than when large, slow biplanes operated cross-Channel services off grass airfields! We are now beginning to approach a design of convenient short-range aircraft, either by rendering the helicopter more economical in the form of the "Rotodyne," or the aeroplane less demanding in flying fields, like the "Turbo-Pioneer." The possibility of operating such aircraft in highly restricted air space awaits little more than satisfactory altimeters and ground-to-air data links; an automatic pilot can then be visualised flying the machine along an approach or holding course computed on the ground and defined by Decca. When such flying is realised, we shall be sharply envious of such a field as Issy-les-Moulineaux for city-centre services. With the committee already calling for the second runway at Gatwick and a possible third airport, it becomes questionable whether the Minister can really justify acquiescence in the abandonment of Croydon aerodrome or inactivity in regard to Hendon. Either might prove invaluable for short-range aircraft operation. Moreover, while London Airport is less than ideal in serving the capital, it is also falling short in serving the rest of the country. Access to the airport the committee leave to the Minister's "urgent consideration," observing with detachment: "We are informed . . . that the Bath Road will be very congested by the early 1960s." Even if the British Transport Commission concludes that the expense of a rail link with the centre of London is commercially justifiable, for many a link with the great railway junction at Reading would be more suitable. Observing that access to the airport from the west is severely handicapped by absence of bridges over the Thames and from the east by half-hearted road improvements at Hammersmith and Chiswick, one looks in vain for an orbital road to link it with the new motorways to the north. The inclusion of civil aviation in the responsibility of the Ministry concerned with surface transport has been the target of much opposition; if it does not lead to air transport being thoroughly integrated with other services, that criticism will be shown to be well founded.

ACTIVITIES OF THE ENGINEERS' GUILD

The Engineers' Guild—we are proud to remember—owes its birth to a long correspondence in our pages, between the wars, on the "Salary and Status of Engineers." Because it came into being shortly before the war, the Guild's early growth was seriously handicapped and it is only since the war that it has increasingly been making its existence felt. It has always had a dual purpose, arising out of its origin. For salary within any profession and status in the eyes of the community at large are only partially linked together. Social status, as for a parson, can be high though the salary linked with it is low and vice versa. One of the objects of the Guild has been to raise the salaries of engineers; another has been to raise their status. In the immediate post-war years its public activities were more related to salary than to status and most of the work it did on behalf of individual members related to the raising of salary levels. Now, however, it is to embark upon a more ambitious and better balanced programme. An attempt to establish a definition of the engineering profession is to be made, a survey of salaries is to be carried out and the Guild's public relations programme designed to eliminate the widespread ignorance about the work of engineers is to be extended.

The moment to adopt an energetic programme is well chosen. For in carrying out the task it has set itself the Guild is likely to find itself assisted by other bodies deeply sympathetic to its aims; and also by the engineering industry itself, despite the natural tendency of accountants upon firms' boards to keep salary scales as low as possible. For the shortage of technologists in industry, and the likelihood that the shortage will be prolonged unless a greater number of able men can be attracted into industry, has already led to offers of starting salaries, by some firms, comparable in the living standards they will uphold with those ruling pre-war; and it has caused those firms to realise that unless the status of engineers is raised in the eyes of the public the men are unlikely to be forthcoming. The major engineering institutions of this country, as chartered learned societies, cannot take any overt action towards the raising of salaries. But they can do, and are doing, much to raise the status of engineering as a profession by their efforts to attract more youngsters into engineering as a career. For it is properly their function educationally to assure not only that educational standards are sufficiently high to support the reputation of engineers but also that a sufficient number of young men attain those standards. Indeed, if there was time to exhibit patience, it would be reasonable to expect that the salary situation in industry would right itself. For many youngsters entering industry are now receiving adequate salaries, certainly comparable with the salaries they would receive in other professions; and as they grow older no doubt they will demand and obtain commensurately larger salaries. It is the adequacy of the salaries of older men at present within industry that can be doubted. Unquestionably in many firms those salaries do not allow these men to retain in society the same relative place as in pre-war days. But possibly that is too much to ask, in any case. For the political parties in this country seem to be agreed that incomes were too steeply graded before the war and that in consequence the higher executive to-day (in all professions) must accept relatively lower emoluments than he did pre-war. Certainly, as a consequence of the growth of surtax percentages as incomes increase, very high gross salaries indeed would have to be granted to yield a gradation of net incomes as steep as that ruling pre-war. According to the *Economist*, a man with a wife and two children earning £1200 per year in 1938—by no means a "top" salary—would have to earn over £5600 a year now to have the same net real "differential" But, possibly because men over forty in established positions have no desire for a change of employment and possibly because firms have felt that Governments must sooner or later reduce taxation levels, salaries in the upper ranges have tended, we think, to advance too slowly. It will be interesting to see what the Guild's investigations reveal about salaries.

But a satisfactory salary is not all that engineers desire. There is no doubt at all in our minds that in this country engineers are not granted the honour that is their due. In certain other countries, notably the United States and, we believe, the U.S.S.R. it is different. But here the illusion persists that only those educated in the arts and the humanities are truly cultured. The engineer is eyed askance. At school it is often not the more talented boys who are advised to take up engineering as a career. That is a profession regarded as suitable for those not abundantly supplied with brains but with a liking for doing things with their hands. The public often proves unable to distinguish between the "engineer" who works at a bench or in a garage and the professional engineer capable of designing bridges, dams, power stations, aircraft, water supply schemes, roads, railways and the like, not to speak of overseeing their construction or directing their operation. We have more than once been half-amused half-irritated, on being introduced to an artist, to observe his dismay at meeting an engineer, and to note his transparent relief when we explain that it is our job to write about engineers. Writing, it appears, is more respectable! In the U.S.A. no such invidious distinctions are drawn. Engineers are at least as much honoured as doctors or lawyers or accountants. Their value to their country is acknowledged. So it should be here; and so it would be were the work that engineers do better understood and were it realised that in taking an engineering training a youngster undergoes a discipline of the mind at least as severe as that experienced by an arts graduate and one just as capable of fitting him eventually for a high administrative position. We congratulate the Guild upon its determination to take a more active part in line with the objects for which it was created.

A Seven Day Journal

London Airport Development

THE London Airport Development Committee, set up in October, 1955, under the chairmanship of Sir Eric Millbourn, was instructed to make recommendations for the next phase of development and to meet requirements for (*a*) future passenger handling, (*b*) accommodation for freight handling, (*c*) hangars in the maintenance areas, (*d*) apron accommodation, (*e*) car parks, and (*f*) the internal road system. Its report was published recently, and shows that it believes that traffic will increase so fast as to saturate the air traffic control within the next ten years : the level of activity will then be roughly three times as many passengers and twice as many aircraft movements as at present. To handle the passengers and freight that will be able to land and take off, the present central terminal area will not be large enough : rather than transfer the long-haul operators from their present congested base at London Airport North to an outlying maintenance area, the committee recommends that No. 4 runway be withdrawn from use, followed, if necessary, by the No. 6 runway parallel to it. The central terminal should have " fingers " to allow the passengers to pass on foot and under cover to their aircraft. A separate building for freight handling should be built near the present temporary sheds. The parking of cars for long periods near to the terminal should be discouraged. These further developments will cost about £17,000,000, bringing the total expenditure to about £47,000,000 : the committee remarks that this is not large compared to the cost of modern aeroplanes.

The committee also recommends urgent consideration of the second stage of development of Gatwick Airport (see page 140, July 31, 1953) and of improved main road approaches. It calls for further study of the ground handling problems of large jet aircraft, and suggests that the North terminal should be reserved for helicopter use until it is proved that helicopters can share the aeroplane terminal.

F.B.I. Overseas Scholarships

LAST week the third annual report of the Federation of British Industries Overseas Scholarship Scheme was published. This scheme provides training with British engineering firms for selected graduate engineers from the Commonwealth, South and Central America and the Middle East, and by March 31 last a total of 147 engineers from twenty different countries had come to Britain for training ; sixty-five are still training here and eighty-two have now returned to their own countries. The report goes on to say that the scheme has important long-term objectives which go far beyond its immediate purpose of training in Britain engineers from developing countries overseas. The underlying assumption is, of course, that the engineers trained under this scheme will rise to positions of influence in their own countries and, having become familiar with British engineering products and practice, will be disposed in later years to " buy British."

The report emphasises that, as the scheme has progressed, one of its particularly satisfactory features has been the continued high quality of the scholars, not only as engineers but also as men. In selecting the scholars, the Federation relies upon the judgment of representative committees in each of the countries concerned, based either on the British Embassy or on the United Kingdom High Commission. These committees include responsible engineers of United Kingdom and local nationalities. It is acknowledged that it is too early to assess the results of the scheme in terms of increased trade, although some specific cases are already known in which former scholars have been able to influence the purchase of British equipment. At the present time there are 154 firms and organisations participating in the scheme.

The Engineer
100 Years Ago
(AUGUST 7, 1857)

"LAYING DOWN THE ATLANTIC TELEGRAPH"

" The Agamemnon arrived at Queenstown on the 30th ult., having been engaged during the trip from Greenwich in testing practically the form and suitability of the machinery to be used for paying out the cable. Mr. C. T. Bright is to take the entire control and responsibility of depositing the cable. During the progress of the Agamemnon to the Downs the apparatus for regulating the delivery of the cable into the sea were kept continually in motion by the small engine on board which is connected with it ; the sheaves and gearing are said to have worked well, and without noise or vibration. . . . . .

" Some highly successful experiments were at the same time performed with an electrical log invented by Mr. Charles Bright for the purpose of continuously ascertaining with accuracy the rate at which the ships are sailing, and thereby of enabling him to give corresponding directions as to the rate of paying the cable so as to prevent the possibility of any unnecessary strain being put upon it. The log is suspended in the sea from the ship's quarter by a line, carrying within it a wire insulated by gutta percha, which is in connexion with a battery and electro-magnet contained within an indicating instrument on deck. This is so arranged that at each revolution of the wheel below an electric current is broken, and by the deflection of a magnet which forms part of the circuit a step by step movement is communicated to a register which indicates the distance run and rate made by the vessel."

The report records that Sir Edward Thompson, chairman of John Thompson, Ltd., has succeeded Sir Arthur P. M. Fleming as chairman of the F.B.I. Overseas Scholarships Committee.

British Association's Dublin Meeting

THE 119th annual meeting of the British Association for the Advancement of Science is being held this year in Dublin from September 4 to 11. It will be the fifth annual meeting to be held in Dublin, previous meetings having been held in 1835, 1857, 1878 and 1908. The president of the Association this year is Professor P. M. S. Blackett, who will deliver his address, " Technology and World Advancement," in the library of the Royal Dublin Society on September 4. Sir David Anderson is the president of Section G, Engineering, and his address, entitled " Education and Training for the Engineering Industry," will be delivered on Friday, September 6 ; other papers in this section will review developments in telecommunications and computing.

A number of other sections will contribute to the theme underlying Professor Blackett's address, and many of the papers will be of interest to engineers. Dr. H. J. Bhabha will deliver an evening discourse on September 6, entitled " On the Economics of Atomic Power Development in India, and the Indian Atomic Energy Programme," and Sir Sydney Caine will deliver a public lecture on September 9 entitled " Education for Development."

The scientific programme this year, it is stated, will have an agricultural slant, and the president of Section M, Agriculture, Sir James Turner, will speak on " The Role of Agriculture in the National Economy." A number of special exhibitions have been arranged this year, including agricultural science, medical photography and atomic models in glass. Scientific films will be shown every day, and on Saturday, September 7, there will be a special programme of research films.

Appointments to Electricity Council and Central Electricity Board

THE Minister of Power, Lord Mills, has announced that, with effect from September 1, Sir Henry Self has been appointed chairman of the Electricity Council, Sir Josiah Eccles and Professor R. S. Edwards are to be deputy chairmen, and Lord Citrine joins as part-time member of the Council from January 1, 1958. Sir Christopher Hinton becomes Chairman of the Central Electricity Generating Board, his deputy being Mr. C. R. King. Mr. F. H. S. Brown and Mr. E. Long are to be members of the Board. Further appointments to both Council and Board have still to be announced.

Sir Christopher Hinton has been managing director of the United Kingdom Atomic Energy Authority's Industrial Group since 1954, and has the Calder Hall nuclear plant to his credit. He will now be responsible for new nuclear power stations in Great Britain. Lord Citrine takes up his part-time appointment after the dissolution of the Central Electricity Authority, of which he has been chairman since its formation in 1947.

Standardisation of Nuclear Plant Practice

REPRESENTATIVES of some thirty countries have been meeting in Geneva to discuss unification of practice with nuclear power plant. It is hoped to recommend standards that will define satisfactory methods of operation, and that will help to improve trade in plant and equipment. Three working groups are likely to be set up to deal separately with the terminology and symbols used in nuclear science, those features of the performance of reactors that have any bearing on safety of operation, and the personal safety of workers, not only at nuclear power plants, but also in such activities as industrial radiography. The occasion is the first meeting of the new committee on nuclear energy formed by the International Organisation for Standardisation. The British delegation of nine is led by Mr. H. A. R. Binney, Director of the British Standards Institution, and includes representatives from the United Kingdom Atomic Energy Authority, the Central Electricity Authority, and three of the industrial groups of the Nuclear Energy Trade Association's Conference.

The Big Hill, Canadian Pacific Railway

By EDWARD H. LIVESAY

(No. II—*Concluded from page* 150, *August* 2)

IT need scarcely be said that no speed was ever, nor has since been, attempted in either direction over this sinuous, difficult piece of line between Stephen and Field ; none is done there to this day, or through the Selkirks either, despite flexible, smooth-running diesel motive power, heavy steel, and so forth ; safety of operation is still the overriding consideration. Not even the " Cannon-Ball Special," I am convinced, did anything spectacular over these sections ; this was a train run to demonstrate to the British Government the possibility of fast mail service, and was said to have covered the distance between Vancouver and Montreal in 63½ h. Somehow I am not prepared to accept this story at face value—it rather comes into the same category as No. 999's 112 m.p.h., which was a mechanical impossibility, for one thing. Assuming the distance to Montreal to have been much the same as it is to-day, 2882 miles, which it is safe to do, the average speed works out at 45·4 m.p.h.—over rough track, 65 lb steel, with small-wheeled engines incapable of really high speed—no, it does not sound likely. The time, 63½ h, is 9½ h less than taken by the new diesel-hauled super-" Canadian " to-day, notwithstanding all the advantages enjoyed by the latter of vastly better track and equipment. The engine that took the " Cannon-Ball " over the Big Hill was No. 313; the machines used elsewhere are not on my records. The reader may believe the story of the flight of the " Cannon-Ball " if he so chooses—myself, I remain sceptical.

With regard to the Mallet engines referred to earlier, the first, No. 1950 (Figs. 7 and 8) was built and began work in 1909. After two years' close observation of the engine's running in ordinary service, it was decided to make certain alterations in the five engines subsequently built (Fig. 9), both structural and dimensional ; they were five in number, Nos. 1951–55, and were turned out in 1911. From Figs. 7 and 8 it will be seen that the

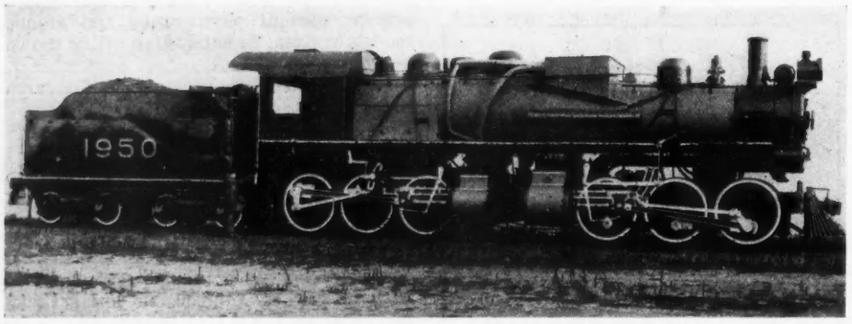


Fig. 7—0-6-6-0 Mallet locomotive (No. 1950)

design differed from the generality of Mallets in several ways, chiefly in that both pairs of cylinders were placed between the two groups of driving wheels. This was claimed to simplify the pipe layout, in association with a reduction in the number of flexible joints and risk of steam leakage. It also shortened the wheelbase and overall engine length, making accommodation in the existing sheds possible. Piston-rings could be removed by taking off the cylinder heads after disconnecting the rods from the crossheads, and the valves could be attended to in the same way.

The boiler Fig. 10 was in three sections, the first being practically a feed-water heater, the ring being of small diameter without steam space, and the injectors discharging into it ; it was connected with the third or steam generating section by equalising pipes. The second or middle section contained the superheater, formed of sixty-nine double loops of seamless steel tubing dropped in from above ; each of the elements connected with the saturated and superheater ends of the header in the usual way. The rear section or boiler proper carried the dome and regulator, and the large 58 square feet firebox was coal-fired.

The regulator was in a separate outside casting, taking steam from the dome ; two 5in pipes then conveyed it to the superheater, outside pipes connecting this with the h.p. cylinders. All these pipes were, of course, high pressure, but as all were on the rear part of the engine no flexible joints were necessary. The exhaust from the h.p. cylinders passed to receivers on both h.p. and l.p. cylinders ; the ratio of l.p. to h.p. cylinders was 2·18/1. The exhaust pipe from the l.p. cylinders to the smokebox had ball joints at both ends, allowing for a movement of 2 deg. 34 min. on a 20 deg. curve, the maximum the engine was called upon to negotiate. Had the l.p. cylinders been arranged in the usual way, in front of the leading group of wheels, three universal joints and two expansion joints would have been necessary, instead of only one packed joint and two ball rings, as used on these original engines.

Piston valves with h.p. admission inside and l.p. outside, Walschearts-operated, were employed, flexible connections in the gear preventing variation in travel by the front set of gear on curves. The cut-off of the two sets of valve gear could be varied independently, and both were controlled by a steam-operated power cylinder 6in in diameter.

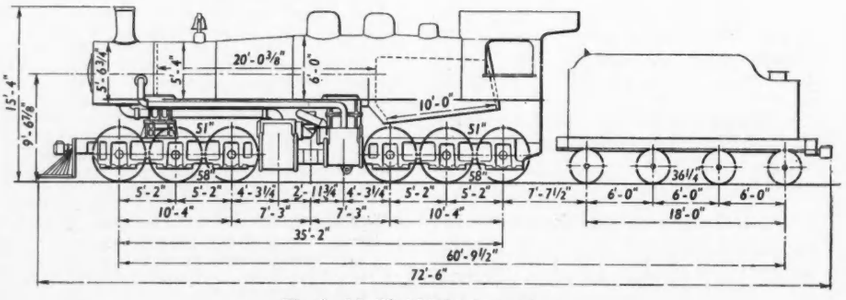


Fig. 9—Modified Mallet locomotive

The two groups of wheels were equalised separately, the front set being also cross-equalised, but not the rear group. Approximately 9000 lb more weight was carried by the front group, to obviate the effect of pushing or pulling a train, which in both cases tends to reduce the weight on the front group, and as the factor of adhesion was only 4·57, about as low as was desirable under the conditions these engines would work, the transfer of weight from the front truck, reducing its adhesion too much, was undesirable ; the 9000 lb offset this.

The engine being largely experimental, many tests were made to determine if the desired results were being attained ; not to find coal and water consumption so much as to check the design as a whole, and discover if changes were called for. Five factors were especially important : (1) receivers, exhaust pipes and connections ; (2) boiler and

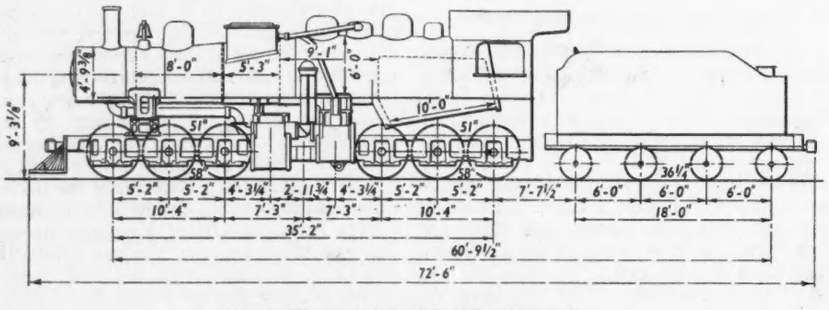


Fig. 8—Diagram of No. 1950 Mallet locomotive

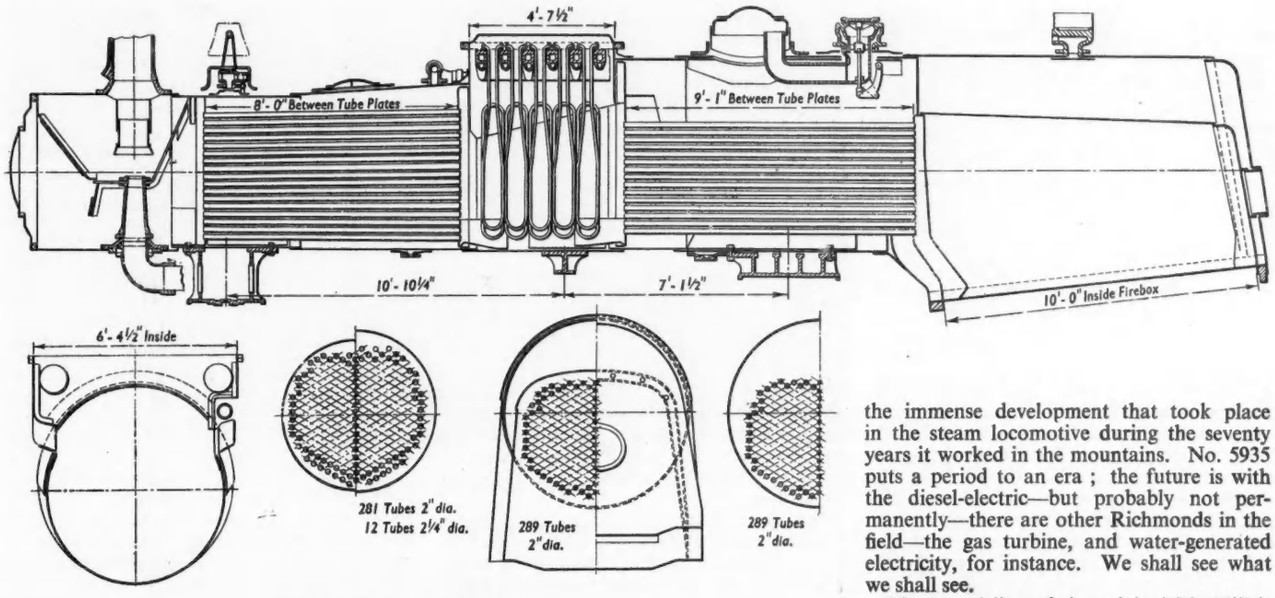


Fig. 10—Boiler of Mallet locomotive

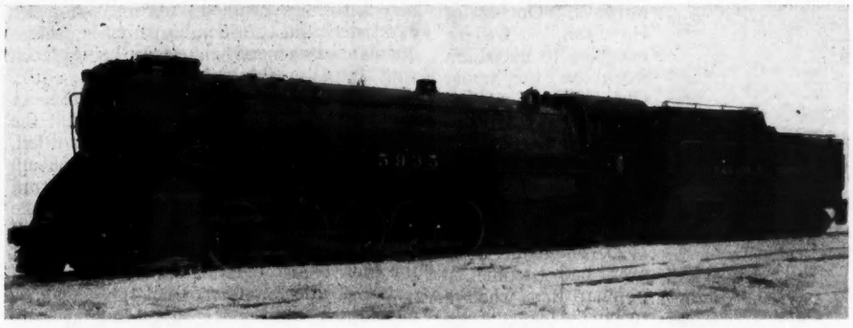


Fig. 11—2–10–4 mixed-traffic locomotive

machinery—whether the former was of sufficient capacity, and the latter satisfactory ; (3) the engine's ability to take curvature freely at ordinary speeds while both heading and backing ; (4) its ability to develop the calculated horsepower ; and (5) the most satisfactory cylinder dimensions and arrangement of superheater and reheater. Nos. 1, 2 and 3 were settled by observations on the engines while running, and Nos. 4 and 5 called for the use of a dynamometer car. The first engine was designed for experimental work, as to the size of the cylinders by fitting them with liners, and the outside arrangement of steam pipes made alterations to superheater and reheater possible at small cost. It was apparent from the first that receiver and pipe design was satisfactory, and no leaks developed. Curves were taken freely, and it was proved that the engine did less damage to them than the usual 2–8–0 type with its rigid wheelbase of 15ft 10in and weight of 185,000 lb.

The first engine had cylinders 22in and 32½in by 26in, with a reheater between h.p. and l.p. cylinders. After several tests, cylinders 23½in and 34in by 26in were substituted, and the later engines the same size. These Nos. 1951/5 (Fig. 9) were fitted with Vaughan-Horsey superheaters installed in the smokeboxes and took the form seen in the outline. But though working successfully, due to excessive cost of maintenance they were converted to 2–10–0 simple engines in 1916/17, with 23½in by 32in cylinders and 58in wheels, in which shape the writer rode them on several occasions before they were sent to Montreal for work as transfer engines ; they were still there in 1952.

During subsequent years the power of the steam locomotive working over the Big Hill increased greatly, and bigger loads were handled, culminating in such trains as " The Dominion," 1200 tons, hauled by two such engines as No. 5935, 2–10–4 (Fig. 11), the last steam locomotive built by the C.P.R. in 1949 ; they worked between Revelstoke and Calgary until displaced by diesel-electric engines in 1953/4, when they were relegated to freight work east of Calgary to Medicine Hat—where I still hope to renew acquaintance with them in the near future. These fine engines have cylinders 25in by 32in, driving wheels 63in, grate area 93·5 square feet, burn oil fuel, with a heating surface of 7086 square feet, steam pressure 285 lb, weighing with tender 327 tons. Fig. 11 shows clearly the immense development that took place in the steam locomotive during the seventy years it worked in the mountains. No. 5935 puts a period to an era ; the future is with the diesel-electric—but probably not permanently—there are other Richmonds in the field—the gas turbine, and water-generated electricity, for instance. We shall see what we shall see.

The actual line of the original Big Hill is seen running across the middle of the picture (Fig. 12); it is now part of the trans-Canada Highway ; to automobiles the 1 in 22 gradient is scarcely noticeable. In the upper right the entrance and exit of the upper spiral can be seen ; in the middle foreground is the 180ft tunnel, through which the line continues towards Field, which lies just out of sight in the distance. The lower spiral is just outside the south-western corner ; the train, a short one headed by a 2–10–4, is approaching it. I have been through these tunnels variously positioned—in train, cab, steam and diesel—and sitting over the cow-catcher, the latter, with the engine going down at 10 m.p.h., giving the most all-embracing observation point ; it included two shower-baths in the upper spiral, which was why the engineer induced me to ride on the " breast-beam." In the absence of steam locomotives the tunnels are now clean and smokeless, but not nearly so interesting—like going through a drainpipe on a tram.

In conclusion, my thanks are due to Mr.

Fig. 12—Present and former locations of the route

March, until recently Chief of the Public Relations Department, C.P.R., and other officials, for their assistance in the preparation of this article, and for the photographs and diagrams, included in it. Some of the photographs are historic, and it is regretted that space limitations have led to several being omitted. My own observations have extended over forty years, being made during scores of passages over this unique terrain, the first only just too late to negotiate the Big Hill itself. The bibliography includes the *American Engineer and Railroad Journal* and the *Railroad Magazine*.

Motor Ship "Glen Sannox"

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

FOR very many years the Firth of Clyde was served by three fleets of steamers second to none round the coasts of the British Isles, the three Scottish railways being in active competition. While the North British Railway did not serve the Isle of Arran the other two railways were keen rivals for the island traffic, and in the year 1890 the Caledonian Steam Packet Company closely allied to the Caledonian Railway, put the fast and, for that day, luxurious paddle steamer "Duchess of Hamilton" on the service between Ardrossan and Arran, and she soon secured the bulk of the island traffic, being far superior to the "Scotia," built in 1880, and plying between the mainland and Arran for the Glasgow and South Western Railway. This railway accepted the challenge and in 1892 the paddle steamer "Glen Sannox" (Fig. 1), built and engined by J. and G. Thomson, Ltd., of Glasgow, appeared on the scene. She was larger and faster than her rival, and with her two funnels and one pole mast was a beautiful ship. Her principal dimensions were: length, 260·5ft; breadth, 30·1ft; depth, 10·1ft; tonnage, 610 gross. Her paddle wheels were driven by compound diagonal engines having cylinders 34·5in and 74in diameter respectively, and a stroke of 60in. On her trials she attained a speed of 19·23 knots.

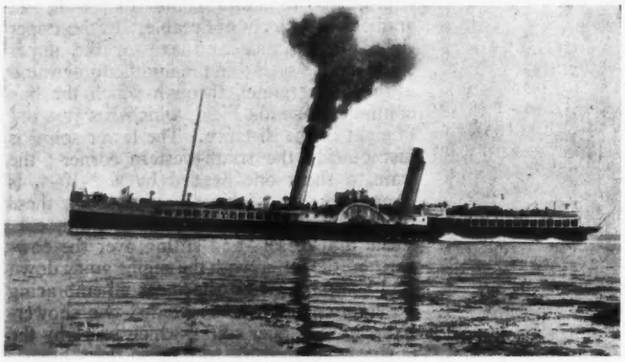


Fig. 1—The first "Glen Sannox"—1892

With two such steamers in active rivalry Arran enjoyed probably the best service then or even up to the present time, but it was not long before the two railways came to a working agreement, and for many years "Glen Sannox" maintained the sailings for both railways, "Duchess of Hamilton" being relegated to excursion work on the upper Clyde. "Glen Sannox" was found unsuitable for war work, and remained on her recognised sailings until she was broken up at Port Glasgow in 1925. The name, however, had become so popular that when a turbine steamer was ordered for the service, incidentally the first to be built after the war on assuming her duties in 1925 it was under the name of "Glen Sannox" (Fig. 2). She was built by William Denny and Brothers, Ltd., and had dimensions very similar to those of her predecessor, for she had a length of 249·9ft; breadth, 30·1ft; depth, 10·1ft; tonnage, 664 gross. She was driven by three steam turbines, coupled direct to triple screws. Originally the property of the London, Midland and Scottish Railway, she was transfered in 1936 to the Caledonian Steam Packet Company, Ltd., thereby enabling her to call at Campbeltown, a port denied the railway. This was with a view to initiating a new service. At the same time appeared on the scene a new steamer "Marchioness of Graham," originally intended for sailings to Arran, and was on that route for some time, but afterwards became somewhat of a utility vessel serving different ports and also a good deal of excursion work fell to her lot during the summer. She is a good-looking vessel (Fig. 3). Built by the Fairfield Shipbuilding and Engineering Company, Ltd., Govan, she came into service in 1936. Her principal dimensions are: length, 220·2ft; breadth, 30·1ft; depth, 10·1ft; tonnage, 585 gross. Her twin screws are driven by four single reduction geared turbines giving her a speed of 17 knots, this being far below that of "Glen Sannox," which, with a speed on trials of 23·75 knots, was easily the fastest of the railway sponsored steamers on the Clyde. It came as a surprise to many when it was known that "Glen Sannox" had been sold to Belgian shipbreakers in July, 1954.

New tonnage was obviously needed for the Arran services, and for a considerable time rumour was rife that an enlarged turbine steamer of the cross-channel kind was to be ordered, and this was probably the case, but the success of the general-purpose motor vessel "Arran," described at some length in these pages,* led to the decision to build a motor vessel, embodying many of the features that had fully justified "Arran" and her two sisters, but considerably larger and more commodious generally, the order being placed with the Ailsa Shipbuilding Company, Ltd., of Troon. Building commenced early in 1956, and in May it was reported that the keel had been laid and bottom plates fitted, but work was delayed owing to the hold up of delivery of materials, and strikes, and delivery dates had to be postponed, but she was ready for service at the end of June, and took up regular sailings from July 5. Without the graceful lines of either of her predecessors, the new "Glen Sannox" (Fig. 4) has a sturdy appearance, and is a good-looking ship by modern standards, although somewhat spoiled by the opening in her side to enable cars to embark and disembark by means of the hydraulically operated platform regardless of the state of the tide. The cars are driven from the platform, when lowered, into the ship's garage.

The leading dimensions of the new vessel are: length, overall, 257ft, between pependiculars, 238ft; breadth moulded, 44ft; depth moulded to main deck, 13ft; loaded draft, 7ft 4in; tonnage, 1000 gross. She is thus a considerable advance in size above the somewhat similar motor vessels on the upper Firth, which have a length of 174ft between perpendiculars and have a tonnage of 567·8 gross. To all intents and purposes, "Glen Sannox" may be regarded as a triple-purpose

* THE ENGINEER, page 200, February 5, 1954.

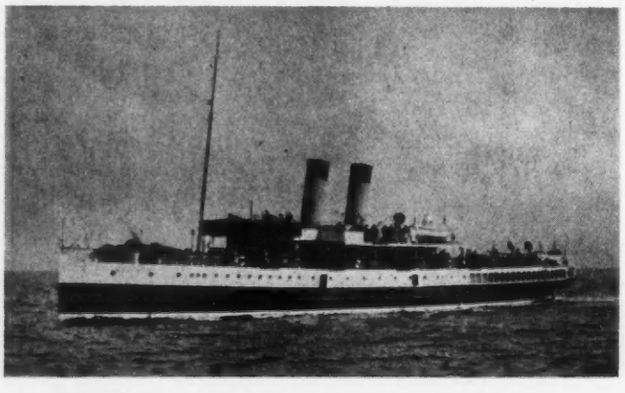


Fig. 2—The second "Glen Sannox"—1925

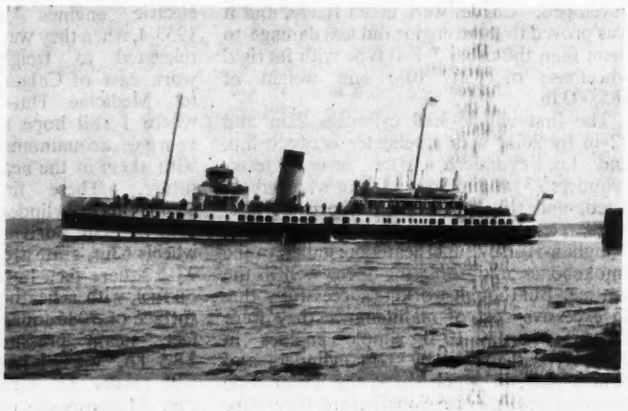


Fig. 3—Geared turbine steamer "Marchioness of Graham"—1936

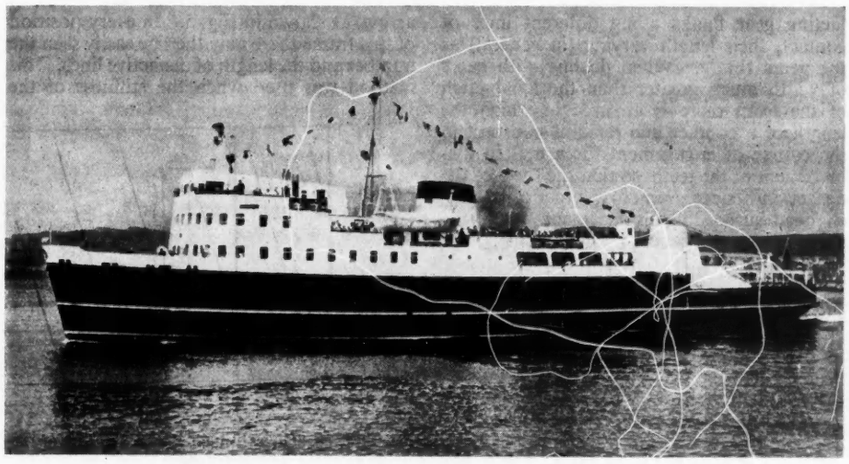


Fig. 4—The third "Glen Sannox"—1957

vessel in that she fulfils the functions of a cross-channel mail boat with up-to-date accommodation for 1000 passengers, while also designed for the specialised carriage of cars, of which forty can be carried at a time and, finally, there is a cargo deck which can take about 40 tons of cargo, the use of containers on trailers being encouraged as facilitating quick despatch. Special arrangements have been made for the conveyance of livestock by the provision of portable stalls, which can be erected in the cargo deck. In the event of no cargo being carried it will be possible to handle an increased number of cars.

The passenger accommodation is of a high standard and special attention has been paid to making it an all-weather vessel, and there is an observation lounge at the forward end of the boat deck capable of seating eighty-two persons, while in the main lounge on the upper deck there is seating capacity for 222, this lounge being situated in the forward end of the vessel, while at the after end of the same deck there is a combined cafeteria and dining saloon which can accommodate sixty persons at a sitting. In addition, on the lower deck there is a commodious smoke room and bar. The saloons are panelled in various kinds of specially chosen woods.

The main propelling machinery consists of two Sulzer two-cycle, direct-reversing, direct-injection, trunk piston engines, type 8MD42, each engine being rated at 2200 b.h.p. at 360 r.p.m. Each engine has eight cylinders with a diameter of 420mm and a stroke of 500mm. The vessel attained a speed on trial of 17 knots; though low compared with that of her predecessor, it is one considered suited to her varied purposes. Vertical scavenge pumps are attached to the side of each cylinder, and are driven from the connecting-rod through links and a rocking lever. The suction and delivery valves are of streamlined flap design. Air is drawn from the engine-room through silencers. The single-collar Michell thrust blocks are built into extensions of the engine bed-plate. The intermediate shafts are of forged steel and are supported by five Cooper roller bearings on each line of shafting. The tail shafts are also of forged steel, and are carried in cast iron stern tubes with white metal-lined brass bearing bushes. Between the stern tube and "A" bracket the shaft is protected by a non-rotating sleeve, and the whole is filled and lubricated with Neox oil. A Newark oil-retaining gland is fitted between the "A" bracket and propellers. The three-bladed propellers have a diameter of 6ft and pitch of 7·63ft, and were made by the Manganese Bronze and Brass Company, Ltd. Most of the auxiliary pumps and air compressors are of Hamworthy manufacture and comprise two electrically driven air compressors, type 2TM5, one sea-water cooling pump, one standby sea or fuel water cooling pump, one fresh water cooling pump, one lubricating oil pump capable of supplying both engines, one general service pump, two fuel booster pumps, and two fuel valve cooling pumps. In addition to this there are two Sharples fuel and lubricating oil purifiers, and one Spanner "Swirliflow" boiler working at a pressure of 50 lb per square inch, which supplies heating and domestic steam, while there are two Serck fresh water heat exchangers, and two Serck lubricating oil coolers. All the foregoing plant is in the main engine-room. In the generator room are three National R4A3 diesel engines of 165 b.h.p. at 600 r.p.m., direct coupled to British Electric 100kW, 220V generators, also a general service pump, a sanitary pump, a diesel-driven air compressor, and an oily bilge pump, the last four being from Hamworthy. On the boat deck in the funnel base there is a 15kW, 220V emergency generator with a Magator fire pump, belt driven from an extension of the generator shaft.

The vessel is fitted with twin rudders, with electro-hydraulic steering gear being manufactured by MacTaggart, Scott and Co., Ltd. There is also a bow rudder. All modern aids to navigation are supplied, including radar, Decca and Marconi radiotelephone.

The new ship will provide a greatly improved service to and from the island, and during the summer months there are to be four sailings in each direction daily, Mondays to Fridays, and additional sailings on Saturday, while a new late sailing at 7.20 p.m. to Fairlie pier will be the means of allowing a long day on the island. With the introduction of the new "Glen Sannox" the rates for transport of cars have been considerably reduced, giving a saving of over £2 on the return passage, the return rate for a car not exceeding 13ft being £3 10s., including the driver's fare, and the maximum charge being £6, rates which compare very favourably with other car ferries.

Incidentally, recently all railway steamers were transferred to the Caledonian Steam Packet Company, Ltd., and "Glen Sannox" will prove a notable addition to a fleet of nine steamers and ten motor vessels. Thanks are due to British Railways, Scottish Region Public Relations Officer, for the photograph of the new "Glen Sannox."

Load Distribution on Helical Gear Teeth

By DR. M. D. TRBOJEVIC, A.M.I.Mech.E.

No. I

The aim of experiments carried out between 1953 *and* 1955 *in the Department of Applied Mechanics at the University of Sheffield, and at the Laboratory for Machine Members of the University of Belgrade, was to determine the deflection of a rubber tooth loaded along different lines of contact. Load distribution along lines of contact for various positions of the contact lines and for various helix angles was found. A method for determining partial loads acting on teeth simultaneously in contact was attained. Conditions were investigated under which the load distribution is most convenient and the position of the least favourably loaded contact line was determined.*

THE paper is based on experimental data obtained by research carried out on a rubber tooth. The laboratory part of the research began at the end of 1953 at the Post-graduate Department of Applied Mechanics in the University of Sheffield, England. Experiments were continued in the course of 1954–55 in the Laboratory for Machine Members of the University of Belgrade, Yugoslavia, with the assistance of the Mechanical Institute of the Serbian Academy of Sciences. The first set of apparatus by means of which experiments were carried out was made in the laboratory of the Post-graduate Department, and the second, an adaptation largely of the first, in the workshop of the Mechanical Institute. The aim of the research was to investigate, on the basis of experiments, the behaviour of a rubber tooth under load. In making the tests the conditions imposed were intended to represent the contact between two teeth in a pair of gears, each of which has a large number of teeth, which therefore approximate in shape to rack teeth.

Theoretical Background

During the experiments a helical tooth was replaced by a rack tooth. When such a tooth is loaded along an imaginary line of contact by a number of unit forces (here unit force =force per unit length, which was 13mm), deflection of the tooth along this line will be in inverse proportion to the stiffness of the tooth. When there are two teeth engaged deflection depends on their combined stiffness. If the combined stiffness varies along the line of contact the load distribution will not be uniform. In order to determine the load distribution experimentally the rubber tooth has to be loaded with unit forces varying in intensity. If such forces can be found

which produce a constant total deflection for the corresponding contact lines the problem of the load distribution is solved. A constant deflection means that both deflection curves are congruent. It was assumed that in addition to the tooth only

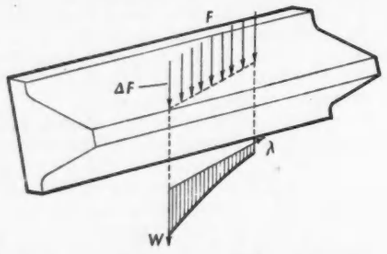


Fig. 1—The rack tooth loaded along an imaginary line of contact, and the deflection caused by such a load

its immediate neighbourhood is deformed, while the body of the pinion and the rim of the gear are assumed to be absolutely rigid.

Definitions

The Base Cylinder is the cylinder from which the involute helicoid surfaces are developed. It corresponds to the base circle of the spur gears.

The Addendum Cylinder is the cylinder in whose envelope all crests are contained.

The Central Plane is an imaginary plane containing both axes of the gears.

The Plane of Contact is an imaginary plane tangential to the base cylinders.

Any *Contact Line* is the line of intersection of the gear flank by the plane of contact.

The Active Part of the Contact Plane is that part of the contact plane that lies inside the addendum cylinders of the engaged gears. Lines of contact lie within the active plane of contact.

The Normal Pitch in the Contact Plane is the distance between adjacent contact lines ; it is

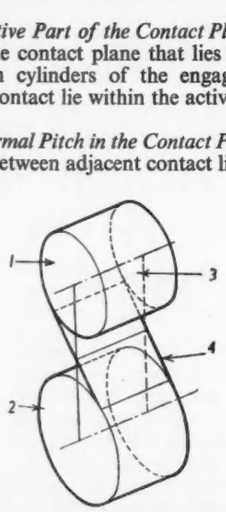


Fig. 2—The base cylinders (1 and 2) central plane (3) and the contact plane (4)

equal to the common normal base pitch of the teeth of the two gears.

The contact plane intersects at every successive instant a number of pairs of contacting gear flanks along different lines of contact, their length varying (in general) as the gears rotate. When dealing with gears of width much greater than the axial pitch of the teeth there is an area in which the length of a contact line remains constant in the course of engagement for a certain displacement of the teeth, so that the form of the deflection curve remains practically unchanged during this displacement.

Fig. 3 shows a helical rack tooth. Plane *A*

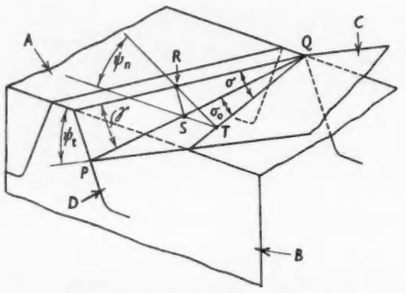


Fig. 3—Connection between the angle of the contact line and toe helix angle

is parallel to axes of gears. Plane *B* is transverse plane, perpendicular to axes. Plane *C* is contact plane, and plane *D* is flank of tooth of imaginary rack meshing with both gears. The crest of the imaginary rack tooth lies in the plane *A*. The line of contact *PQ* is the line of intersection of planes *C* and *D*.

Referring to Fig. 3, it will be seen that $\tan\gamma = RS/QR = RS/RT \cdot RT/QR = \sin\psi_n \cdot \tan\sigma$. By means of this formula angles σ were calculated for chosen angles γ.

The contact plane of helical gears intersects many pairs of teeth simultaneously so that engagement occurs along a number of contact lines. Generally, the total length of the line of contact, equal to the total of the individual lines, varies during the engagement. It will remain constant only when the ratio between the face width and the axial pitch is an integer.[8, 9]

In order to obtain a better understanding of the manner in which helical gears engage, it is useful to imagine the contact plane as a ribbon wrapped round both base cylinders, as shown in Fig. 4. If this ribbon were pro-

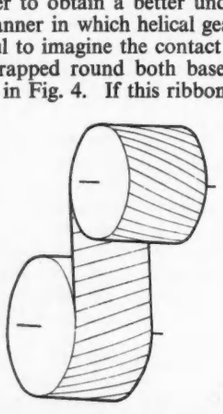


Fig. 4—The contact plane as a part of a ribbon wrapper round both base cylinders

vided with parallel lines inclined to the axes of the gears at an angle σ_0 at a mutual distance equal to the normal base pitch, these lines would correspond to the contact lines. Only those lines are active which lie within the active part of the contact plane. In order to study the behaviour of the engaged teeth the length of the various lines of contact should be known for every phase of the process. The length of these lines may be easily determined if a series of straight lines are drawn inclined at an angle σ_0 and separated by intervals equal to the normal base pitch and an imaginary frame whose size corresponds to the active part of the contact plane is moved in the direction of the arrow, as shown in Fig. 5. In every position of this frame there may then be easily seen the number and the length of the active lines. This method was used when the stiffness of the

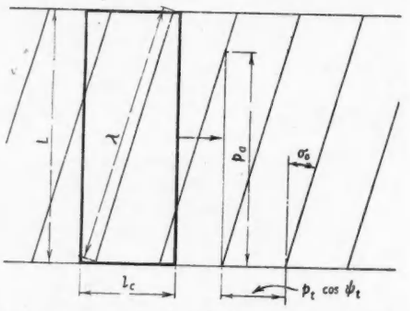


Fig. 5—Contact lines within the active part of the contact plane

system of teeth simultaneously in contact was computed.

The change of length of total line of contact during the engagement causes relatively abrupt changes in the load acting on individual pairs of teeth, and in case of great speeds causes additional dynamic loads. It is therefore important to investigate the conditions under which these changes will tend to be a minimum.

The loading of the teeth during the period of engagement occurs in the Hooke's law region. We may therefore compare a pair of teeth with two springs coupled in a series. The main feature of such a coupling is that the same load causes a total deflection equal to the sum of the partial deflections.

The following symbols will be used :—

w_i', w_i''—Partial deflections.
w_i—Total deflection.
F_i—The force per unit length of the contact line causing deflection w_i, or deflections w_i' and w_i''.
C_i', C_i''—" The tooth stiffness " per unit length of the contact line, corresponding to the stiffness of the spring, and
C_i—The combined stiffness per unit length of a pair of teeth.

In these terms : $w_i = w_i' + w_i''$, and as $w_i' = F_i/C_i'$ and $w_i'' = F_i/C_i''$, so $w_i = F_i(1/C_i' + 1C_i'') = F_i/C_i$. Consequently, $1/C_i' + 1/C_i'' = 1C_i$, and

$$C_i = \frac{C_i' \cdot C_i''}{C_i' + C_i''}.$$

As previously stated, there are usually many pairs of teeth simultaneously engaged. If we do not take into account deformation of the rim of the wheel and the torsional deformation of the pinion and assume that under load only the teeth and the immediately adjoining metal in the body of the gear are deformed,[11] the total deflection (at the lines of contact) of all pairs simultaneously engaged will be the same. Such pairs may therefore be compared with a number of springs coupled in parallel. The main feature of such a coupling is that the deflection is everywhere the same, the total force being equal to the sum of the partial forces.

$$w = F_1/C_1 = F_2/C_2 = \ldots = F_n/C_n,$$

and as $F = F_1 + F_2 - \ldots + F_n = w.(C_1 + C_2 + \ldots + C_n) = w \cdot C$, so

$$C = \sum_{i=1}^{n} C_i.$$

C is the stiffness of the system of teeth simultaneously engaged, i.e. of all the pairs at the moment of observation, and is equal to the sum of all the combined stiffnesses of the pairs of teeth simultaneously engaged.

Notation

γ—The angle between the contact line and the tip of the rack tooth.
δ—Proportional variation in the specific load distribution.
λ—Length of the contact line.
μ—Thousandth of a millimetre.
σ—The helix angle.
σ_0—The base helix angle.
ψ_n—The normal pressure angle.
ψ_t—The transverse pressure angle.
C—The stiffness of the system of teeth simultaneously engaged (equal to the sum of all the combined stiffnesses of the pairs of teeth simultaneously engaged).
C_i—The combined stiffness.
C_i', C_i''—Tooth stiffness.
E—Young's modulus.
F—The force.
f—Specific load.
h—The lever arm length of the force acting on a tooth.
L—The length of the tooth=the face width.
l_c—The length of the path of contact.
p_a—Axial pitch.
p_t—Circular pitch.
w—The deflection.
z—The number of pipe loads.

If, then, a certain force acting on the gears is assumed, and if this force is divided by the stiffness of the system of teeth, the quotient is the deflection of the system and it is common to all the pairs of simultaneously engaged teeth,

$$w = F/C.$$

By multiplying the deflection so obtained by the combined stiffness of a single pair, the partial force acting on this pair may be obtained,

$$F_i = w \cdot C_i.$$

If this force is divided by the length of the contact line of the pair under observation the specific load acting on the unit length will be obtained. During the engagement, the force acting on a tooth changes as well as the length of the contact line, and, consequently, the specific load $\Delta F_i = F_i/\lambda_i$. If the total variation of the specific load during the entire period of engagement for all pairs of teeth is divided by the mean specific load, the proportional variation in the specific load distribution of the system of teeth will be obtained.

$$\delta = \frac{\Delta F_{max} - \Delta F_{min}}{\Delta F_{mean}}.$$

Outline of the Treatment of the Problem up to the Present Day

The problem of load distribution on helical gear teeth is not treated extensively in literature, and most of the treatment is theoretical. Ch. W. MacGregor,[1] when dealing with this problem, studies the deflection of a thin rectangular plate of uniform thickness rigidly clamped along one of its long sides. To simplify the problem MacGregor made the assumptions that the long sides of the plate $x=a$ and $x=0$ extend to infinity ; that the plate is rigidly clamped along $x=0$; that the deflection of the plate is small compared to its thickness ; that force F, acting perpendicularly to the plane of the plate, is distributed along the outer edge $x=a$; and that the thickness h is small compared with the width a. But assumptions involving a plate of indefinite length, a concentrated force and relatively thin plate can by no means be described as realistic, which means that the results cannot be applied to the designing of gear teeth, but may be regarded only as a contribution to the study of behaviour of idealised teeth under a static load.

The same is, on the whole, true of D. L. Holl's solution.[2]

H. E. Merritt,[3] in his treatment of this problem, assumes that the combined stiffness is proportional to $l/(h_1^3+h_2^3)$ (Fig. 6), and

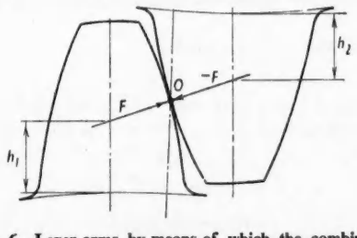


Fig. 6—Lever arms by means of which the combined stiffness of a pair of the teeth was determined

concludes that the greatest load will be in the middle of the contact line and that the maximum intensity is approximately 1·5 times the mean. Merritt's conclusion is based on considerations which are undocumented, and he neglects the influence of the neighbouring parts of the tooth on the stiffness at the point under observation. As a result of this, Merritt, in his conclusion, makes a quantitative mistake.

E. Buckingham[4] arrives at an equation for the deformation of the tooth analytically, assuming that the deformation at the tip is 1·5 times greater than that in the middle of the tooth. Buckingham takes into account torsional deformations of the pinion and concludes that the teeth of the pinion on the end nearer to the coupling are deformed more than on the other end. In a specific example the load at the end nearer to the coupling is nearly twice as much as the mean load, whilst the load on the other side is negligible (one-fortieth of the mean). This Buckingham

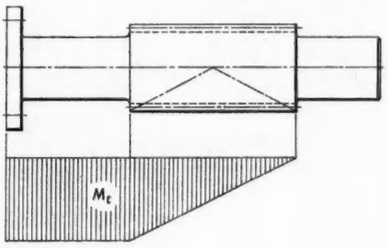


Fig. 7—The pinion in one piece with the coupling accompanied by a diagram of the moment of torsion

explains by the linear increase in the moment of torsion (Fig. 7). This result seems to be exaggerated and needs to be checked experimentally. In the case of helical gears, the difference between the maximum and the minimum load is considerably less. In the given example it is about 30 per cent.

M. Trier[5] assumes that the mean lever arm through which the force acts on helical teeth is about two-thirds of that for spurs. Under this assumption Trier gives his formula for module calculations. Professor Vitas,[6] when considering the lever arm, stated that the decrease of the lever arm will be between 35 to 45 per cent and proposed, for safety's sake, a decrease of 37 per cent.

H. Walker[12] gives conclusions regarding helical teeth based on his research on a spur rack tooth made of steel. In his opinion, based on comparison with spurs, maximum loading will be at the ends of the contact line, reaching three times the mean load. Walker comes to this conclusion through overestimating the increase of the stiffness due to the influence of the unloaded part of the tooth on the loaded part. In this paper it has been shown that this influence is not so important and that besides this " buttressing effect " there is an influence exerted by the " neighbouring load." Deflection at a point on the contact line depends not only on the load at this point but on the neighbouring load as well. At the end of the contact line the load on one side of the point under observation is zero.

G. Niemann and H. Glaubitz[7] investigate the influence of the helix angle on wear, the life of the tooth, stresses in the root, the creation of noise and heating—all for short helical gears. Experiments carried out at Brunswick Technical College by means of a power circulator have shown that gears with helix angle of 15 deg. and 45 deg. have a load-carrying capacity which is about 30 per cent greater than that of the spurs. Optimal values of the helix angle regarding load-carrying capacity would be about 30 deg.

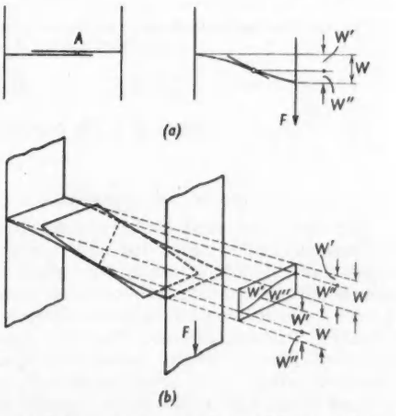
C. Weber and W. Thuss[8] deal respectively with the load-carrying capacity of the teeth and the ultimate load which helical teeth are able to stand. The intensity of the tensile stress in the root was taken as the criterion, ignoring stress concentration. A given formula for bending stress was divided into two parts, one containing constants and the other depending on ψ_n and σ as variables (Fig. 3). By the use of this second factor, called the " comparative factor," it can be seen how ψ_n and σ influence the load-carrying capacity. In the mathematical part of the paper the authors give analytical formula for the maximum normal stress in the root of the tooth, derived from the main equation of the theory of elasticity of the plates. This result has no practical value.

From this brief outline it may be seen that the problem has not been solved, and that for its mathematical treatment assumptions are necessary, which lessen the value of the results so obtained. There does not seem to be any hope that the problem will be mathematically solved at all. It is therefore necessary to find a method for its experimental treatment.

Experimental Work

The purpose of the experimental work was to carry out the research on load distribution along various lines of contact as a basis for a more elaborate study of the engagement process of helical gears. The load distributions given by Merritt and Walker differ so much that their statements throw doubt on each other. It was therefore thought desirable to carry out some further tests, with simple apparatus, that could be expected to throw more light on the subject and perhaps to establish the order of the difference between the highest local intensity of tooth loading on a tooth and the mean loading corresponding to total load and length of line of contact. The first step was to apply uniform loading along a straight line on the flank of a rack tooth and to measure the deflection of the tooth at points on that line. From this the combined deflection of a mating pair of such teeth could be found for various points on the assumed line of contact. (This condition is possible only when at least one of the mating teeth has some curvature, however slight. Otherwise contact at any instant extends over an area.) All combined deflection curves, obtained by adding together the corresponding deflections, had their minimum in the middle of the curve. On the basis of these results it could be concluded that the maximum combined stiffness occurs in the middle of the contact line, and that in order to obtain a constant combined deflection it is necessary to increase the load in the middle of the contact line or to decrease that at the ends.

The need for a constant combined deflection along a contact line may be explained in the following way. When two teeth, for instance, two idealised teeth resembling rigidly clamped plates are engaged, one of which is fixed while the other moves in the direction of the acting force (Fig. 8),



(*a*) When the line of contact is parallel to the clamped edges (left, unloaded teeth, right, loaded)
(*b*) When the line of contact is inclined to the clamped ed ges

Fig. 8—Partial and combined deflections of a pair of idealised teeth

combined deflection under force F is equal to its relative displacement w. This is valid whether the contact line is parallel to the clamped edges or not. In the case of an inclined contact line the surfaces of the teeth will be distorted.

Experimental work was divided into three phases. In the first phase, deflection curves

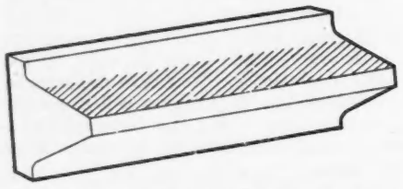


Fig. 9—Contact lines on the flank of a helical pack

under a uniformly distributed load were obtained. This was done for various positions of the contact lines and for various angles γ. In the second phase a load distribution was sought which would give constant combined deflections along single contact lines. In the third phase the case of unequal face width was investigated. All readings were made for γ angles of 0 deg., 5 deg., 10 deg., 15 deg., 20 deg. and 25 deg., corresponding (with ψ_n=20 deg.) to the helix angles of 0 deg., 14·4 deg., 27·3 deg., 38·1 deg., 46·7 deg. and 53·8 deg. Loading of the rubber tooth was produced by means of a number of pipes into which steel balls were inserted as weights. The lengths of the various contact lines were each made integral multiples of the distance between adjacent pipes, this distance being the fixed spacing of location holes in certain parts of the apparatus. The maximum length of the contact lines, in terms of the number of pipes, depending on angle, was : 20 when γ=5 deg., 11 when γ=10 deg., 8 when γ=15 deg., 6 when γ=20 deg., and 5 when γ=25 deg.

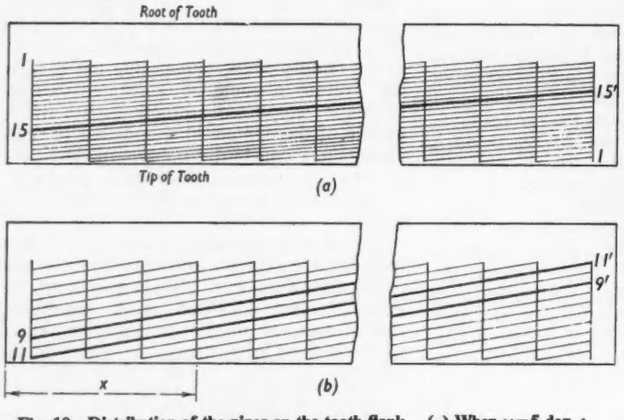
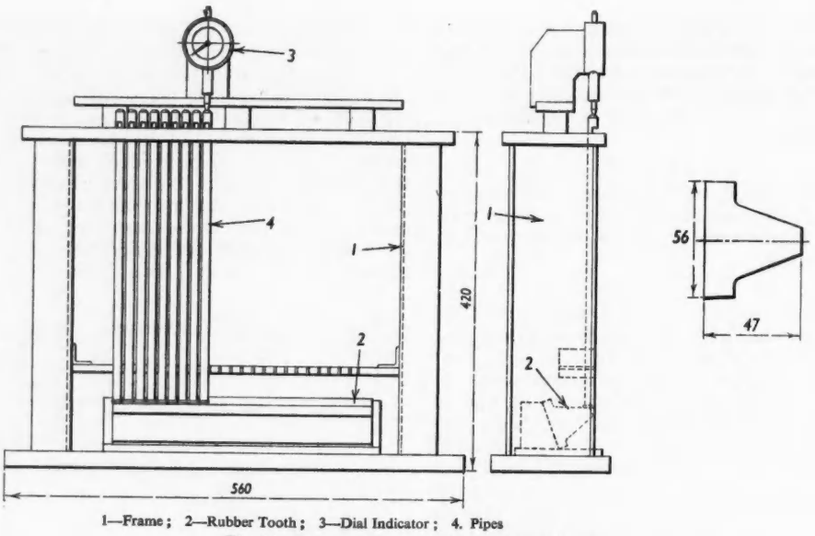


Fig. 10—Distribution of the pipes on the tooth flank. (a) When γ=5 deg. ; (b) When γ=10 deg.

Fig. 10 shows the positions of the pipe axes on the gear flank.

Description of the Apparatus

The apparatus used for measuring tooth deflections (Fig. 11) consisted of a relatively rigid frame 1, which has a base plate on which the experimental rubber tooth 2 was placed. On the top of the frame there is a slide for the dial indicator 3. The upper plate of the frame has twenty-five holes, which, together with the leading plate placed a third of the way up the frame, ensured the correct position of the pipes. The pipes, made of brass, have a conical cover at their upper end and at their lower end a 12·8mm rectangular cover with convex surface.



1—Frame ; 2—Rubber Tooth ; 3—Dial Indicator ; 4. Pipes

Fig. 11—The apparatus and the experimental tooth

Each of the pipes has an opening through which the balls are inserted and a longitudinal cut through which the balls may be seen so that they may be counted. The weight of a single pipe is 138·1 grammes. The distance between the pipe axes is 13mm. The balls used weighed 1·462 grammes. In the first phase of experimental work ten balls were inserted on each occasion, the maximum number being forty balls. This made the total weight 196·5 grammes. Deflections were measured by a dial indicator of industrial type with an accuracy of 0·001mm. The dial indicator was fixed to its holder, which could move along the above-mentioned slide, and the stylus touched the upper end of the pipe.

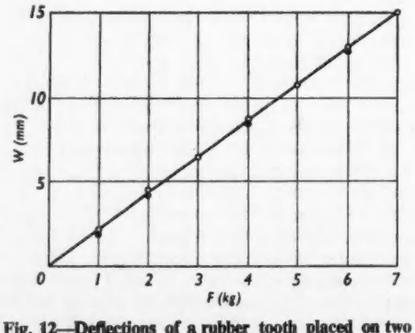


Fig. 12—Deflections of a rubber tooth placed on two holders and loaded in the middle as a function of load

Description of the Rubber Tooth

The rubber tooth is a rack tooth of standard form, 300mm long, module 15mm, obtained by a die-pressing process at elevated temperature. The tooth was bonded to a hardwood holder fixed to a steel baseplate. Young's modulus in bending was determined in the Belgrade University Material Testing Institute. The rubber tooth, placed on two holders at a distance of 250mm, was loaded in the middle on an " Avery " spring testing machine. Deflections were measured under varying loads and their mutual dependence determined (Fig. 12), and it was established that :

$$E_{rubber} = E_{steel} \cdot 2{\cdot}85 \cdot 10^{-5}.$$

(To be concluded)

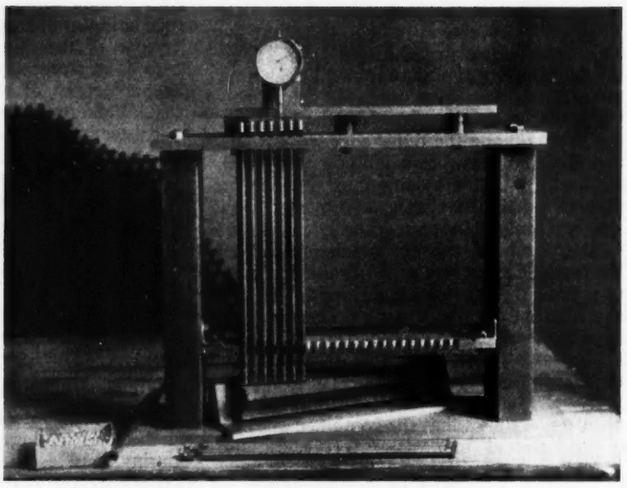


Fig. 13—The complete apparatus

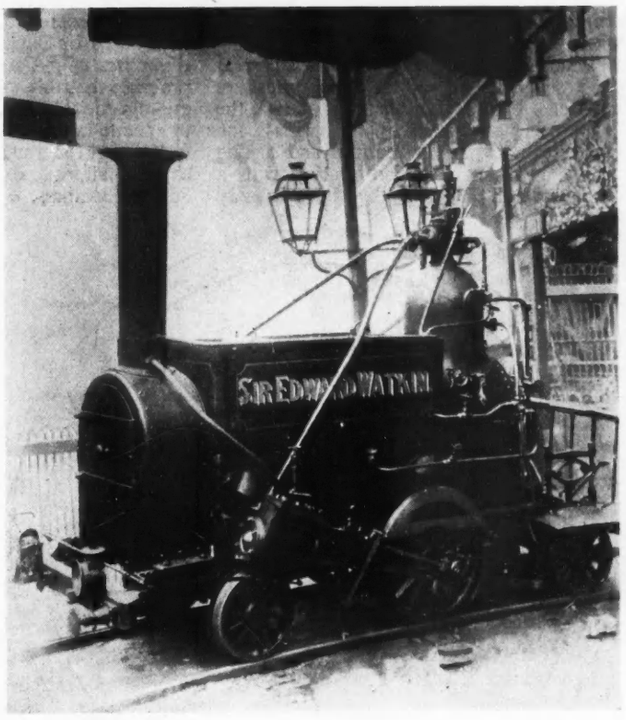
Transistorized Equipment for Measuring Time and Frequency.—We learn that Venner Electronics, Ltd., Kingston By-pass, New Malden, Surrey, is now producing a transistorized equipment able to measure any frequency in the range 10 kc/s to 50 kc/s, the period of any waveform from one hundred-thousandth to 10 kc/s, and the time interval between two consecutive pulses (from the same or independent sources) in a range from one ten-thousandth of a second to eleven-and-a-half days. Digital techniques are used throughout, and presentation is on five meters, one for each decade, calibrated from 0 to 9.

Fairground Tunnel Railways

By R. A. S. ABBOTT*

No. I

When the fascinating subject of fairground machinery was so ably dealt with by Mr. P. W. Bradley in THE ENGINEER *during* 1954, *brief mention was made of that rare form of "ride," the circular tunnel railway. These railways were never very numerous and only about fifteen are known to have been operated by showmen in Great Britain. This article traces what is known about them, and, in particular, the peculiar locomotives used on them.*



THE origin of the tunnel railway is shrouded in obscurity, although the author believes the reason for such a ride attaining a certain amount of popularity in the last decade or so of the nineteenth century may simply have been because a topical subject of that period was a suggested tunnel between England and France, and the English showmen of the day were quick to adopt the idea as a new fairground attraction. Many of these railways were decorated with scenes of the English and French coasts, or were named after main line railways that would have been directly connected with any tunnel across the Straits of Dover. The present writer's interest in this subject was first aroused in November, 1952, when it became known that a locomotive and train of open carriages still existed in Berkshire, and a visit was arranged to inspect and photograph them. The builder of this set is at present unknown, but detailed reference will be made to it later in this article.

Although not a tunnel railway in the true sense, it seems appropriate to include first a description of a remarkable machine designed and patented by two Cambridge engineers, Mr. W. Reynolds, of Coton, and Mr. C. T. King, of Swaffham. This invention, British patent No. 16,187, of 1886, comprised a radial-axled railway locomotive and train running on a small diameter track within the circle of a double-crank, three-abreast, galloping horse roundabout. The illustration, Fig. 1, is reproduced from the drawing accompanying the patent specification, and the relevant paragraphs of this specification describing the patentees' "Improvements in Merry-go-rounds or Roundabouts" reads as follows :—"In the drawing *A* represents a locomotive to which two or more carriages are connected, the locomotive being of ordinary construction and serving to propel the train along a circular track *B* suitably supported round the central pillar *C* of the apparatus, preferably upon trucks *D* and if necessary, by struts of jacks *D'*, as shown. The funnel *A'* of the locomotive is extended inwards and communicates with a chamber *E* surrounding pillar *C*, round which it can turn, such pillar being hollow and having openings *C'* through it, whereby the smoke from the locomotive can pass from chamber *E* into and up through pillar *C* and out at top of same, so that the pillar thus forms an up-take for the locomotive. As the locomotive travels along track *B* it carries the chamber *E* with it, and the latter is provided with a toothed wheel *F* gearing with pinion *G* carried by the stationary frame *H* and the axis of which has at its upper end a second pinion *I* gearing with an internal toothed wheel *J* forming part of the frame *K* to which the swifts *L* carrying the horses *M*, suspended from their outer ends, are secured. The horses are thus made to travel round outside the train, in this instance in an opposite direction to the latter.

"The train is preferably made up so that the end carriage touches or almost touches the front of the engine, to which it will be connected, so the train is really endless. Arms are preferably arranged to project radially at intervals all round chamber *E* and these are connected to one or other of the carriages so that the train will not be able to leave the track, and will also assist in driving. The driving axle of the locomotive may be provided with a toothed wheel to engage a circular rack *Q* running parallel with the track. As the speed at which the locomotive is driven will probably be higher than it is advisable to impart to the train through the locomotive wheels, we prefer to mount the latter so that they can revolve loose on their axles, and to provide the driving axle with a

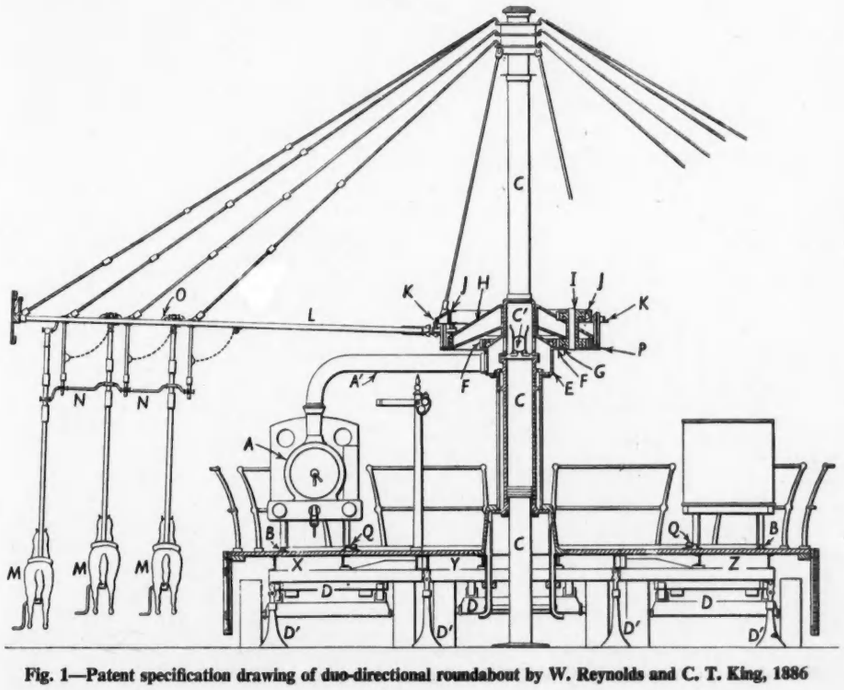


Fig. 1—Patent specification drawing of duo-directional roundabout by W. Reynolds and C. T. King, 1886

* Member, Newcomen Society

toothed pinion to gear with an intermediate wheel which engages the circular rack *Q*.

" Each horse *M* of the same set is carried by a separate rod, all of which rods are connected to two crankshafts *N* and *O*, the latter being supported by the swifts *L* so that it can revolve in bearings and having at its inner end a pinion gearing with a toothed wheel *P* carried by the stationary frame *H* so that as the swifts revolve the crankshaft *O* will be actuated and thus impart galloping or other movements to the horses." This galloping movement of the horses was covered in a previous patent by Reynolds and King, No. 15,383, of 1885.

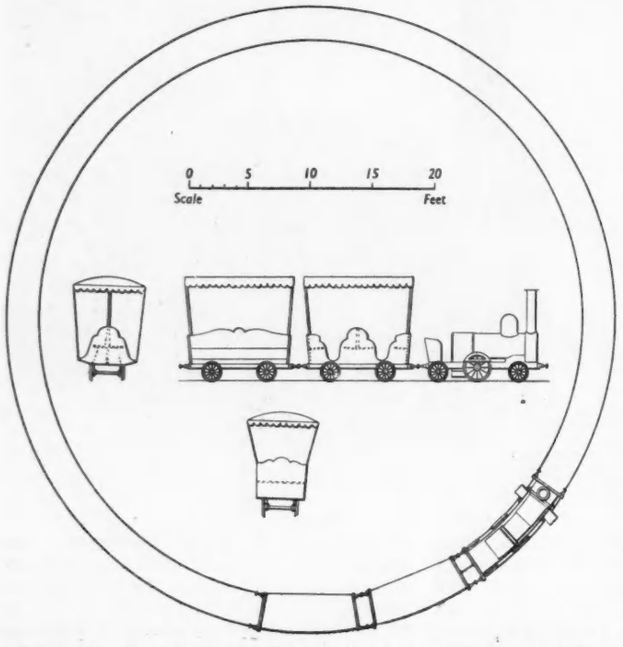


Fig. 2—Circular fairground railway designed by Savage Bros. in 1885

In 1890 a machine corresponding very closely to the patent specification drawing was built by Charles Burrell and Sons, Ltd., St. Nicholas Works, Thetford, and a photograph, discovered by Mr. R. H. Clark, is reproduced on page 110 of his recent book *Chronicles of a Country Works*. It is very probable that this was the only example of a duo-directional roundabout-cum-railway ever to operate in this country.

A design for what may have been the first circular fairground railway was prepared by Savage Brothers, St. Nicholas Ironworks, King's Lynn, in 1885, and Fig. 2, reproduced from the original drawing, shows this to have been a circle of 50ft diameter and of 2ft 9in gauge. The train consisted of a 2–2–2 outside cylinder, well-tank locomotive, and two open-sided canopied carriages, one with transverse seats arranged in two compartments, and the other with longitudinal back-to-back seating. It is obvious that the drawing is incomplete in many ways, but one detail in the construction of the locomotive is most unusual : the boiler barrel was designed in two rings curved to the same radius as the circle of rails, although it is doubtful whether such a " refinement " would have been used in actual practice. But according to what became a customary and, indeed, essential practice axles were set radially to the curved track and the diameters of outer and inner wheels differed from one another so as to eliminate slip. The approximate dimensions of this locomotive were : driving wheels (outside rail), 2ft diameter ; radially set leading and trailing wheels (outside rail), 1ft 4½in diameter; centres of axles (on outside rail) leading to driving, 3ft 4½in ; driving to trailing, 3ft 2½in ; boiler barrel length, 4ft 2½in ; diameter over large ring, 1ft 9in ; length of firebox, 1ft 8in ; width, 2ft ; height to top of boiler from rail level, 3ft 8in ; height to top of chimney from rail level, 7ft 1½in ; overall length of frame on outside of curve, 9ft. The carriages had wheels of 1ft 4½in on the outside rail, and had a frame length measured on the outside of the curve of 8ft 4½in. The canopy roof was 8ft 1½in above rail level.

The makers are unable to say whether this railway was ever constructed, for no record of it appears in any of the surviving order books. For whom it was designed is not now remembered, although a Continental client has been suggested.

The tunnel railway proper seems to have become popular quite suddenly in the middle eighteen-nineties, for during 1895 no less than twelve such sets were built by three engineering firms in England. Savage Brothers produced a standard design and built six railways and locomotives for the following showmen in 1895 :

Engine No.	
641	P. Collins.
642	W. Davies
643	Marshall (resold to M. Jarvis)
644	Thurston
645	Tuby (resold to Toursaint, Lille)
646	Symonds

The plan drawing and elevation drawing, Fig. 4, give a very clear idea of the general layout, and a great improvement was a raised track, 2ft 10in above ground level, which not only rendered the train more conspicuous at a crowded fair, but was in part laid on the platform of a road wagon. There was never any necessity, therefore, to remove the locomotive from the rails.

The outside diameter of the track was 39ft 6in, laid to a gauge of 3ft, while the whole structure, 49ft 6in diameter, was covered with a white awning and had an overall height to top of centre pole of 23ft. The tunnel entrance was 8ft 6in wide by 9ft high. A feature of unusual interest in the layout of these sets was the provision of separate boilers for the electric lighting plant, and the organ engine. To work these railways Savage Brothers designed a very attractive

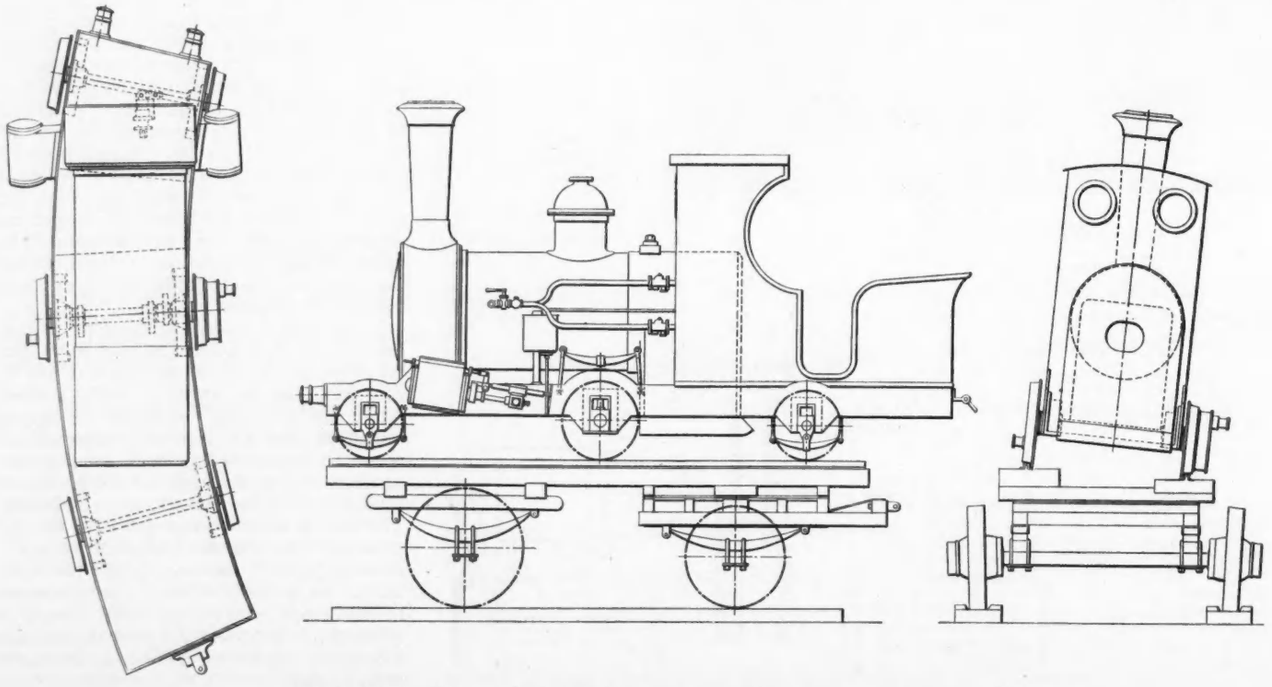


Fig. 3—2–2–2 tank locomotive built by Savage Bros. in 1895, showing curved frame

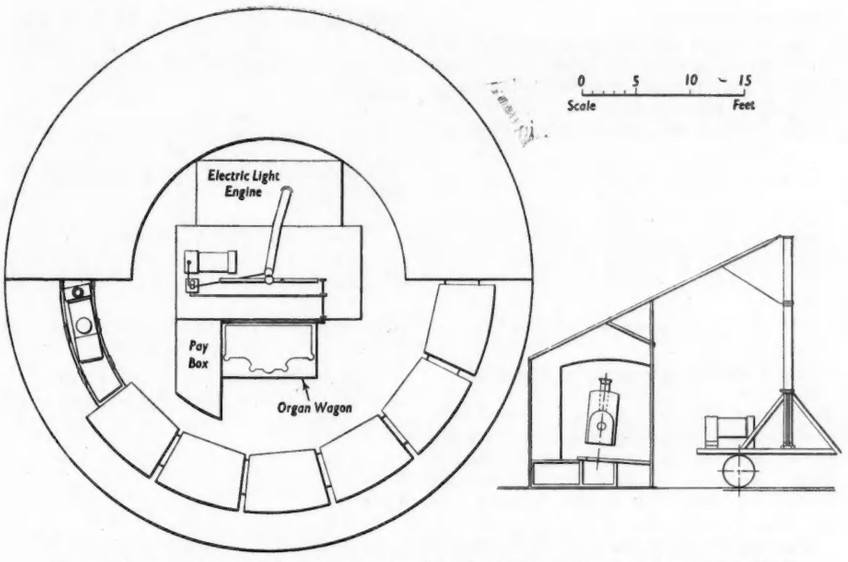


Fig. 4—Plan and elevation of tunnel railway showing raised track, built by Savage Bros. in 1895

2–2–2 tank locomotive with inclined outside cylinders and an abundance of bright brasswork, and Fig. 3 illustrates one of these mounted on its road wagon. The cylinders, 5in diameter by 9in stroke, had the valves on top operated by rocking shafts from inside eccentrics. No provision was made for reversing and an unusual feature was the crank setting, 180 deg. instead of the normal 90 deg. The driving wheels had a diameter of 1ft 6in on the outer rail, while the radially set leading and trailing wheels were 1ft 4in on the outer rail. The wheelbase measured on the outside of the curve was leading to driving, 4ft 6in; driving to trailing, 4ft 1in; overall length of frame outside, 12ft 6in. Half-elliptic underhung springs were provided for the leading and trailing axles, with overhung springs of the same kind for the driving axle. The driving wheel on the inner side incorporated also the brake drum, of 1ft 1in diameter, and the crank-pin was fixed in this drum. The boiler had a length between tube plates of 3ft 9½in; and a diameter of 2ft 1¾in; from the firebars to the crown of the inside firebox the distance was 2ft 4in, and the width of the grate, 1ft 9¾in; boiler working pressure, 180 lb per square inch; length of smokebox, 1ft 2in; height of dome, 1ft 4in; length of chimney, 2ft 8in; height of chimney from rails, 6ft 9in. The boiler feed was by an eccentric driven pump under the smokebox, and by one injector. The curvature of the locomotive frame is very clearly illustrated, together with the mounting of the cylinders and boiler—notice especially that the setting of the cylinders is, necessarily, non-radial—while the end view shows clearly how the locomotive was mounted on a wagon for transport. The carriages were 8ft 6in long on the outer side. Although only six sets are recorded in the "Engine Register" preserved at the St. Nicholas Works, the author understands that engines were occasionally built and omitted from this list, and the locomotive about to be described was presumably one of these.

During the year 1903 there was in operation at the Agricultural Hall, London, the locomotive shown on page 191, and, in *The Locomotive* for March 28, 1903, was said to have been built "a few years ago" by Savage Brothers. It was owned by Messrs. Read and Bailey and formed part of that firm's large travelling circus known as the "World's Fair." This little locomotive of 2–2–2 saddle tank class, with outside cylinders, drew a train of four open carriages and bore the name of "Sir Edward Watkin." The diameter of the driving wheels is stated to have been 2ft, and that of the leading and trailing wheels, on radially set axles, as 1ft 4in, but whether this refers to the wheels on the outside rail is not known. The cylinders, 4¾in diameter by 7¼in stroke, had outside link motion reversing gear, the eccentrics being mounted on return cranks. The boiler, 6ft 10½in long by 1ft 10in diameter, contained thirty tubes of 2¼in diameter. A large dome was mounted on the firebox casing, which was 1ft 9in long and 2ft 1in wide. The overall length was 10ft 6in and height to top of chimney 7ft 4in. The capacity of the saddle tank was 80 gallons, but no bunker was provided for the coke, this being kept in a convenient heap by the side of the track. It will be noticed that the steam and exhaust pipes were very crudely arranged and must have led to considerable condensation.

The weight empty was 2 tons, and 2 tons 6½ cwt in working order. The gauge was 2ft 3in and the axles of the carrying wheels were capable of adjustment radially to suit a similar railway of larger diameter that Messrs. Read and Bailey owned at Blackpool. The springing appears very elaborate for this class of locomotive, full-elliptic springs being used, and in addition large blocks of rubber were inserted in the springs of the leading and driving axles. Stopping was effected by wooden brake blocks, applied by hand, on the driving wheels only. The carriages held eight persons on longitudinal seats with a light canopy overhead. They ran on very small wheels with radially set axles, and were mounted on rubber springs. The outside of the tunnel was painted to represent the English Channel between Dover and Calais.

(To be concluded)

Shock Waves in Helical Springs

By J. DICK, M.A., B.Sc., Ph.D., M.I.Mech.E.

When a helical spring is loaded rapidly, there is likely to be an appreciable transient effect consisting of waves travelling up and down the spring. The stresses resulting from such waves can be calculated when the movements of the ends of the spring, and the conditions of reflection at the ends, are known. A special problem arises, however, in the case of a compression wave of an intensity greater than that which would just give contact between adjacent coils of the spring. In such a case there is "shock" at a wave front which is propagated at a speed greater than that of waves which do not cause contact between adjacent coils. The present article is concerned with the analysis of a simple case of the production and dissipation of a simple shock wave of this type.

Introductory Theory

From the theory of wave motion, the speed of propagation of a disturbance along the axis of uniform spring is:

$$a=\sqrt{\frac{K}{w/g}} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The values of K and w/g in this expression vary with the axial strain, but the rate of propagation expressed as the number of coil pitches per unit time is independent of the strain. This is

$$n=\frac{a}{p}=\frac{a_0}{p_0} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The Intensity of a Disturbance.—The intensity in any part of a wave being transmitted in one direction can be expressed in terms of the change in the local coil velocity (Δv) or the change in the local axial spring force (ΔP).

If $(\Delta v)_f$ is the changé in the local coil velocity due to a forward moving disturbance, the local axial strain is

$$-\frac{(\Delta v)_f}{a},$$

and if $(\Delta P)_f$ is the change in the local axial (compressive) load, then

$$(\Delta P)_f=K\frac{(\Delta v)_f}{a}=\frac{K_0}{a_0}(\Delta v)_f \quad . \quad . \quad (3)$$

By similar reasoning for a backward moving disturbance, we have

$$(\Delta P)_b=\frac{K_0}{a_0}(\Delta v)_b \quad . \quad . \quad . \quad . \quad (4)$$

Overlapping Waves.—When the forward moving and backward moving waves overlap, we have

$$v=(\Delta v)_f-(\Delta v)_b \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and

$$P=(\Delta P)_f+(\Delta P)_b \quad . \quad . \quad . \quad . \quad . \quad (6)$$

These equations give

$$\left.\begin{aligned}(\Delta v)_f&=\tfrac{1}{2}\left\{v+\frac{a_0}{K_0}P\right\}\\ \text{and}\quad (\Delta v)_b&=\tfrac{1}{2}\left\{-v+\frac{a_0}{K_0}P\right\}\end{aligned}\right\} \quad . \quad . \quad (7)$$

The Critical Axial Compressive Force.—Let the spring be formed of wire of diameter d, then contact between adjacent coils occurs when the local axial force reaches the value

$$P_c=K_0\frac{p_0-d}{p_0} \quad . \quad . \quad . \quad . \quad (8)$$

The subscript c indicates that this is a critical value of the axial force. When the local axial force P exceeds the value P_c, the excess $(P-P_c)$ is transmitted by pressure

between adjacent coils, and the local strain due to this excess force is negligible in comparison with the strain

$$\frac{p_0-d}{p_0}.$$

The axial force P_c can be attained by a shockless wave of coil velocity v_c where, following the equations (3) and (4),

$$P_c=\frac{K_0}{a_0}v_c \quad . \quad . \quad . \quad . \quad . \quad (9)$$

From equations (8) and (9) we obtain

$$v_c/a_0=P_c/K_0=\frac{p_0-d}{p_0} \quad . \quad . \quad . \quad (10)$$

Shock Waves

When the net local compressive axial force due to overlapping waves is greater than P_c there is a "shock" effect. The length of spring in which adjacent coils are in contact forms a "piston" in which the coils all move with the same velocity, and there is a "shock" wave front at one end, and in some cases at both ends, of the "piston." The speeds of propagation of these "shock" wave fronts are greater than the values given by equations (1) and (2), and the pressure-velocity relationships differ from those of equations (3) and (4).

For a simple analysis it is assumed that (*a*) there is no rebound due to impact between adjacent coils, (*b*) the strain due to the excess force $(P-P_c)$ is negligible.

Fig. 1 shows the general case in diagram-

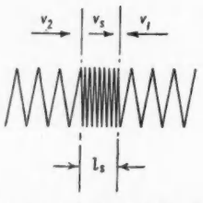


Fig. 1—Showing a "piston" of closed coils

matic form. The coils in the "piston" have a velocity v_s, and in the general case there will be acceleration or retardation, causing a linear variation of axial force from the value P_{sf} at the front of the "piston" to the value P_{sr} at the rear of the "piston."

Shock at the Front End of the "Piston."—The pitch of the coils immediately in front of the "piston" is given by

$$p_1=\frac{K_0-P_1}{K_0}.p_0 \quad . \quad . \quad . \quad . \quad (11)$$

and the weight per unit length of spring in this region is

$$w_1=w_0p_0/p_1=w_0\frac{K_0}{K_0-P_1} \quad . \quad . \quad (12)$$

As the front end of the "piston" is propagated into the region (1) the coils entering the "piston" are compressed from a pitch p_1 to a pitch d, where d is the diameter of the wire.

The number of turns entering the piston per unit time is

$$\left(\frac{v_s+v_1}{p_1-d}\right) \quad . \quad . \quad . \quad . \quad . \quad (13)$$

where v_1 is a backward velocity (Fig. 1).

The speed of propagation of the front end of the piston is

$$v_s+d\left(\frac{v_s+v_1}{p_1-d}\right)$$

which is

$$\frac{v_sp_1+v_1d}{p_1-d} \quad . \quad . \quad . \quad . \quad (14)$$

The mass compressed per unit time is

m=mass per turn × number of turns entering the piston per unit time

$$=\frac{w_0}{g}p_0\left(\frac{v_s+v_1}{p_1-d}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

and since

$$\frac{p_0}{p_1-d}=\frac{K_0}{P_c-P_1} \quad \text{and} \quad K_0w_0/g=\left(\frac{K_0}{a_0}\right)^2,$$

this gives

$$m=\left(\frac{K_0}{a_0}\right)^2\left(\frac{v_s+v_1}{P_c-P_1}\right) \quad . \quad . \quad . \quad . \quad (16)$$

The rate of change of momentum is

$$m(v_s+v_1)=\left\{\frac{K_0}{a_0}(v_s+v_1)\right\}^2\left(\frac{1}{P_c-P_1}\right) \quad . \quad (17)$$

and this is equal to $(P_{sf}-P_1)$.

Hence,

$$(P_{sf}-P_1)(P_c-P_1)=\left\{\frac{K_0}{a_0}(v_s+v_1)\right\}^2 \quad . \quad (18)$$

This equation is valid for $P_{sf}\geqslant P_c$.

Shock at the Rear End of the Piston.—By an analysis similar to the above, the backward speed of propagation of the rear end of the piston is

$$\frac{d(v_2-v_s)}{(p_2-d)}-v_s$$

which is

$$\frac{v_2d-v_sp_2}{p_2-d} \quad . \quad . \quad . \quad . \quad (19)$$

and consideration of the momentum conditions gives

$$(P_{sr}-P_2)(P_c-P_2)=\left\{\frac{K_0}{a_0}(v_2-v_s)\right\}^2 \quad . \quad (20)$$

This equation is valid for $P_{sr}\geqslant P_c$.

The Condition of Zero Shock at the Ends of the Piston

The condition of zero shock at the front end of the piston gives $P_{sf}=P_c$, and in this case, equation (18) gives

$$(P_c-P_1)=+\frac{K_0}{a_0}(v_s+v_1) \quad . \quad . \quad . \quad (21)$$

or

$$(P_c-P_1)=-\frac{K_0}{a_0}(v_s+v_1) \quad . \quad . \quad . \quad (22)$$

In each case the positive velocities are those indicated by vectors in Fig. 1. Considering v_s positive, equation (21) applies to the case in which (v_s+v_1) is positive, and in this case coils are entering the front end of the piston; equation (22) applies to the case in which v_1 is negative and numerically greater than v_s, and coils are "peeling off" from the front end of the piston.

The forward speed of propagation of the front end of the piston in the former case is

$$(v_s+nd) \text{ where } n=a_0/p_0 \quad . \quad (23)$$

and the forward speed of propagation of the front end of the piston in the latter case is

$$(v_s-nd) \text{ where } n=a_0/p_0 \quad . \quad (24)$$

The condition of zero shock at the rear end of the piston gives $P_{sr}=P_c$, and in this case, from equation (20),

$$(P_c-P_2)=+\frac{K_0}{a_0}(v_2-v_s) \quad . \quad . \quad (25)$$

or

$$(P_c-P_2)=-\frac{K_0}{a_0}(v_2-v_s) \quad . \quad . \quad (26)$$

In each case the positive velocities are those indicated by the vectors in Fig. 1. Considering v_s positive, equation (25) applies to the case in which v_2 is positive and numerically greater than v_s, and in this case coils are entering the rear end of the piston; equation (26) applies to the case in which (v_2-v_s) is negative, and coils are "peeling off" from the rear end of the piston.

The forward speed of propagation of the rear end of the piston in the former case is

$$(v_s-nd) \text{ where } n=a_0/p_0 \quad . \quad . \quad (27)$$

and the forward speed of propagation of the rear end of the piston in the latter case is

$$(v_s+nd) \text{ where } n=a_0/p_0 \quad . \quad . \quad (28)$$

It is proposed to confine attention here to one case only, that in which coils "peel off" from the rear end of the piston during deceleration. The local axial force P_2 and the local coil velocity v_2 in the region immediately to the rear of the piston result from the superposition of two disturbances.

These are:

(*a*) A disturbance propagated forward—this disturbance is part of the general wave system and its intensity is not affected by the piston conditions.

(*b*) A disturbance propagated backwards from the rear end of the piston. The intensity of this disturbance is determined by the piston velocity v_s and the critical axial force P_c

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Notation.

K—Local axial force required to cause unit strain (the modulus).
w—Weight of a unit length of spring.
p—Pitch of coils in spring.
d—Diameter of wire.
P—Actual local axial force in spring.
$(P)_f$—Part of local axial force due to a forward moving disturbance.
$(P)_b$—Part of local axial force due to a backward moving disturbance.
In general, $P=(P)_f+(P)_b$.
v—Local axial coil velocity.
$(v)_f$—Part of axial coil velocity due to forward moving disturbance.
$(v)_b$—Part of axial coil velocity due to a backward moving disturbance.
In general, $v=(v)_f-(v)_b$.
a—Local speed of propagation of a "shockless" disturbance.
n—Local rate of propagation of a shockless disturbance in coil pitches per unit time.
Thus, $n=a/p$.

The Use of Subscripts.

The constants for an unloaded spring are denoted by the subscript 0. Thus:
K_0—Modulus of unloaded spring.
w_0—Weight of a unit length of unloaded spring.
p_0—Pitch of coils in unloaded spring.
a_0—Speed of propagation of a "shockless" disturbance in an unloaded spring $=\sqrt{\frac{K_0}{w_0/g}}$ (see equation (1)).

The critical axial force is that which just causes contact between adjacent coils. The constants for the critical force conditions are denoted by the subscript c. Thus:
P_c—Critical axial force $=K_0\frac{p_0-d}{p_0}$.
w_c—Weight per unit length of spring under the critical force $=w_0p_0/d$.
v_c—Local axial coil velocity of a single disturbance with unidirectional propagation, giving a local axial force P_c.
From equations (3) and (4) $P_c=v_c\frac{K_0}{a_0}$.

A "shock" condition is association with a "piston" in which adjacent coils are in contact. The "piston" variables are denoted by the subscript s. Thus:
v_s—Axial velocity of coils in the "piston."
P_s—Axial force in the "piston." This is given by the sum of the force P_s and the force due to the contact pressure between adjacent coils.
P_{sf}—Axial force at front end of the "piston."
P_{sr}—Axial force at rear end of the "piston."
l_s—Length of the "piston."
$w_s=w_c=w_0p_0/d$—Weight per unit length of the "piston."
The variables for the region in front of the "piston" are denoted by the subscript 1. Thus:
p_1—Pitch of coils.
P_1—Local axial force $=K_0\frac{p_0-p_1}{p_0}$.
$(\Delta P)_{1f}$—Part of local axial force due to forward moving disturbance.
$(\Delta P)_{1b}$—Part of local axial force due to backward moving disturbance.
In general $P_1=(\Delta P)_{1f}+(\Delta P)_{1b}$.
v_1—Local coil velocity in the region 1.
$(\Delta v)_{1f}$—Part of coil velocity due to forward moving disturbance.
$(\Delta v)_{1b}$—Part of coil velocity due to backward moving disturbance.
In general, $v_1=(\Delta v)_{1b}-(\Delta v)_{1f}$.
(Note that v_1 is a backward velocity as shown in Fig. 1.)
The variables for the region behind the "piston" are denoted by subscript 2. Thus:
p_2—Pitch of coils.
P_2—Local axial force $=K_0\frac{p_0-p_2}{p_0}$.
$(\Delta P)_{2f}$—Part of local axial force due to forward moving disturbance.
$(\Delta P)_{2b}$—Part of local axial force due to backward moving disturbance.
In general, $P_2=(\Delta P)_{2f}+(\Delta P)_{2b}$.
v_2—Local coil velocity in the region 2.
$(\Delta v)_{2f}$—Part of coil velocity due to a forward moving disturbance.
$(\Delta v)_{2b}$—Part of coil velocity due to a backward moving disturbance.
In general, $v_2=(\Delta v)_{2f}-(\Delta v)_{2b}$.

(which is equal to P_{sr} in the case under consideration).

The intensity of the disturbance (b) is given by (7) and (10) as

$$(\Delta v)_{2b}=\tfrac{1}{2}\left\{-v_s+\frac{a_0}{K_0}P_c\right\}=\tfrac{1}{2}(v_c-v_s) \quad . \quad (29)$$

The intensity of the disturbance (a) is given by

$$(\Delta v)_{2f}=v_2+(\Delta v)_{2b}=v_2+\tfrac{1}{2}(v_c-v_s) \quad . \quad (30)$$

From the equations (3), (4), (6), (29) and (30), the local axial force is

$$P_2=\frac{K_0}{a_0}\{(\Delta v)_{2f}+(\Delta v)_{2b}\}$$

$$=\frac{K_0}{a_0}\{v_2+v_c-v_s\} \quad . \quad . \quad . \quad . \quad (31)$$

and since

$$\frac{K_0}{a_0}v_c=P_c$$

from equation (9), we have

$$(P_c-P_2)=\frac{K_0}{a_0}(v_s-v_2) \quad . \quad . \quad . \quad (32)$$

which agrees with equation (26).

THE WAVE SYSTEM RESULTING FROM A SQUARE PULSE OF VELOCITY GREATER THAN v_c APPLIED TO ONE END OF AN UNLOADED SPRING

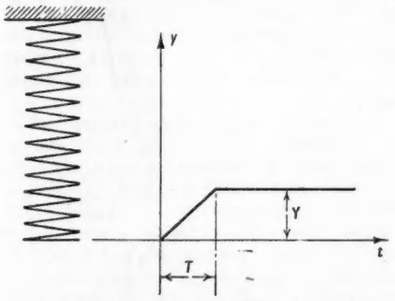


Fig. 2—Showing the $y-t$ diagram for a pulse

Fig. 2 shows the $y-t$ diagram for the pulse, which imposes a velocity Y for a time T.

Let v_{s0} be the velocity of the coils in the "piston" during the period $t=0$ to $t=T$, that is, $v_{s0}=Y/T$. During this period, the front end of the piston is propagated with a speed

$$\frac{v_{s0}p_0}{p_0-d}$$

and from this equation (10), this is

$$v_{s0}\frac{a_0}{v_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

and at the instant $t=T$ the length of the "piston" is

$$l_{s0}=v_{s0}\frac{a_0}{v_c}T-v_{s0}T=\left(\frac{a_0}{v_c}-1\right)Y \quad . \quad (34)$$

When $t>T$, the "piston" decelerates. Let v_s be the velocity of the coils in the "piston" during deceleration, then the axial force at the front end is given by equation (18), with $v_1=0$, and $P_1=0$.

This gives

$$P_{sf}P_c=\left(\frac{K_0}{a_0}v_s\right)^2 \quad . \quad . \quad . \quad . \quad (35)$$

The local axial force at the rear end of the "piston" cannot be less than P_c, hence the decelerating force on the "piston" is

$$(P_{sf}-P_c)=-\frac{w_s}{g}\frac{d}{dt}(l_sv_s) \quad . \quad . \quad . \quad (36)$$

We have also

$$P_c=v_c\frac{K_0}{a_0} \quad . \quad . \quad . \quad . \quad . \quad (37)$$

and

$$\frac{w_s}{g}=\frac{w_0}{g}p_0/d=\frac{K_0}{a_0^2}\frac{a_0}{a_0-v_c} \quad . \quad . \quad . \quad (38)$$

On eliminating P_{sf}, P_c, K_0 and w_s/g from the equations (35), (36), (37) and (38) we have

$$\left\{\left(\frac{v_s}{v_c}\right)^2-1\right\}\left\{\frac{a_0}{v_c}-1\right\}=-\frac{d}{dt}\left(\frac{l_sv_s}{v_c^2}\right) \quad . \quad (39)$$

The value of $d/dt(l_s/v_c)$ is given by the difference between the speeds of propagation of the front and rear ends of the "piston"—that is

$$\frac{d}{dt}\left(\frac{l_s}{v_c}\right)=\frac{1}{v_c}\left\{v_s\frac{a_0}{v_c}-(v_s+nd)\right\}$$

$$=\frac{1}{v_c}\left\{v_s\frac{a_0}{v_c}-\left(v_s+\frac{a_0}{p_0}d\right)\right\}$$

$$=\frac{1}{v_c}\left\{v_s\left(\frac{a_0}{v_c}-1\right)-a_0\left(\frac{a_0-v_c}{a_0}\right)\right\}$$

$$=\left(\frac{v_s}{v_c}-1\right)\left(\frac{a_0}{v_c}-1\right) \quad . \quad . \quad . \quad . \quad (40)$$

From (39) and (40)

$$\frac{d\left(\frac{v_s}{v_c}\right)}{2v_s/v_c+1}=-\frac{d\left(\frac{l_s}{v_c}\right)}{l_s/v_c} \quad . \quad . \quad . \quad . \quad (41)$$

or

$$l_s/v_c=\sqrt{\frac{A}{2v_s/v_c+1}} \quad . \quad . \quad (42)$$

When

$$v_s=v_{s0},\ l_s=l_{s0}=\left(\frac{a_0}{v_c}-1\right)Y \quad . \quad (43)$$

giving

$$\frac{l_s}{l_{s0}}=\sqrt{\frac{2v_{s0}/v_c+1}{2v_s/v_c+1}} \quad . \quad . \quad (44)$$

The deceleration is zero when $v_s=v_c$ and the length of the "piston" is then

$$l_{s0}\sqrt{\frac{2v_{s0}/v_c+1}{3}} \quad . \quad . \quad (45)$$

The time required to change the length of the "piston" from l_{s0} to l_s can be found by eliminating v_s/v_c from equations (40) and (44) and integrating. Since the rate of change of length with time decays as $v_s\to v_c$, an infinite time is required for the "piston" to attain the length given in (45). In the majority of practical cases, however, the decay of v_s is rapid in the early stages and the length of the "piston" is approximately

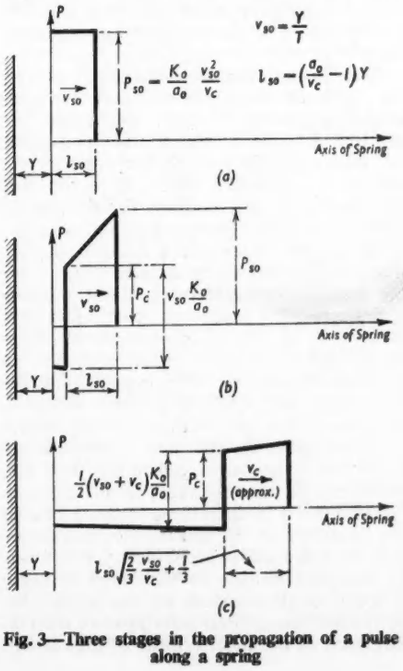


Fig. 3—Three stages in the propagation of a pulse along a spring

equal to the value given in (45) in a short time. Fig. 3 shows three stages in the propagation of a disturbance such as that described above.

In Fig. 3 (a) the pulse given to the end of the spring has just reached its full value. The axial force in the "piston" is constant and from equations (18) and (9) the force is

$$P_{s0}=\frac{1}{P_c}\left(\frac{K_0v_{s0}}{a_0}\right)^2=\frac{K_0}{a_0}\frac{v_{s0}^2}{v_c} \quad . \quad . \quad (46)$$

Also, from equation (34), the length of the "piston" is

$$l_{s0}=\left(\frac{a_0}{v_c}-1\right)Y \quad . \quad . \quad . \quad . \quad . \quad (47)$$

Fig. 3 (b) shows the condition immediately following the state (a). The "piston" is decelerating, and the axial force at the rear end has been reduced to P_c. The coils at the rear end are beginning to "peel off," and the intensity of the first part of the disturbance propagated backwards is given in terms of coil velocity (equation (29)) as

$$(\Delta v)_{2b0}=\tfrac{1}{2}(v_c-v_{s0}) \quad . \quad . \quad . \quad . \quad . \quad (48)$$

This represents a tensile force of magnitude

$$\Delta P=\tfrac{1}{2}(v_{s0}-v_c)\frac{K_0}{a_0} \quad . \quad . \quad . \quad (49)$$

This disturbance is reflected at the end of the spring and hence, at the instant under consideration, the coil velocity immediately behind the "piston" is

$$(\Delta v)_{2b0}-(\Delta v)_{2b0} \quad . \quad . \quad . \quad (50)$$

and the local tensile axial force has a magnitude

$$(v_{s0}-v_c)\frac{K_0}{a_0} \quad . \quad . \quad . \quad (51)$$

The axial force at the front end of the "piston" is a function of v_s, and at the instant under consideration it has not been reduced appreciably from the value given in (46).

Fig. 3 (c) shows the condition when v_s has been reduced to a value slightly higher than v_c. The local axial force at the rear end of the "piston" is P_c. The forward moving disturbance immediately to the rear of the "piston" has the coil velocity given in equation (48), namely,

$$\tfrac{1}{2}(v_c-v_{s0}) \quad . \quad . \quad . \quad . \quad (52)$$

and the local axial tensile force given in (49), namely,

$$(\Delta P)_f=\tfrac{1}{2}(v_{s0}-v_c)\frac{K_0}{a_0} \quad . \quad . \quad . \quad (53)$$

The backward moving disturbance has a coil velocity of

$$(\Delta P)_b=\tfrac{1}{2}(v_c-v_s)\simeq 0 \quad . \quad . \quad . \quad . \quad (54)$$

because v_s is now only slightly greater than v_c, and the local axial force is negligible. Thus

$$P_2\simeq\tfrac{1}{2}\frac{K_0}{a_0}(v_{s0}-v_c) \quad . \quad . \quad (55)$$

Again, the length of the piston has increased during deceleration, and at the instant under consideration it is only slightly less than the value given by (45)—that is,

$$Y\left(\frac{a_0}{v_c}-1\right)\sqrt{\frac{2v_{s0}/v_c+1}{3}} \quad . \quad . \quad (56)$$

A further change occurs when the "piston" reaches a fixed end. The simplest analysis in this case is that given by assuming that the piston velocity is reduced to zero by the impact. The reflected wave which passes backwards along the spring has an intensity indicated by a coil velocity $\frac{1}{2}v_c$ and a local axial compressive force of $\frac{1}{2}P_c$.

LETTERS AND LITERATURE

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ARRIS AND ARRIDGE

SIR,—When I was working in the shops more than sixty years ago, the word "harridging" was commonly used by engine fitters to mean the removal, by a touch with a file, of the sharp or ragged edges left on an article after machining. I have never seen the word written or printed.

R. H. PARSONS

August 3, 1957.

Book Reviews

The Direction of Research Establishments. H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 25s.

THE first Director of Research of the National Physical Laboratory was appointed in 1900 and the Department of Scientific and Industrial Research was founded in 1916. These events marked the birth of the organisation of research in Great Britain and the later years saw the beginnings of many of the large industrial or Government laboratories, each with scores or hundreds of scientists working for them that we know to-day. The present book deals with the problems which arise in the administration of such large research establishments. It is the report of a conference held on this subject at the National Physical Laboratory from September 26 to 28, 1956, which was attended by 150 delegates from seventeen countries, many of them directing research or holding senior positions in such establishments. In our present age this subject is of great importance and this book summarises the best modern thinking upon it. The problems of large-scale research are, however, more easily formulated than solved and the possession of this book will not spare any director of research hard thinking, though it will offer valuable suggestions on almost any topic likely to arise.

The first session of the conference was devoted to discussing the "strategy" of research, and comprised papers by Professor Bernal, on "Fundamental and Applied Aspects of Research Problems," and by Dr. Willis Jackson, director of research and education, Metropolitan-Vickers Electrical Company, Ltd., on "The Research Project; Choice and Termination." All the papers given are summarised in the book, which also contains notes of the salient points in the discussions. The second session was devoted to the problems of the "creativity" of the scientist; and of finance, this latter problem being dealt with by Mr. D. R. Willson, technical secretary of the Atomic Energy Research Establishment, Harwell, in a paper entitled "Budgets and Administrative Controls."

The conference then split into three groups which dealt respectively with (*a*) buildings, workshops and other facilities; (*b*) staff matters, and (*c*) "information" problems—that is, the task of keeping people in a research organisation informed on what is going on elsewhere in their field and of passing on the knowledge the organisation has itself gained, and getting it used by the interest or industry it serves. These groups summarised their findings at a fourth session which discussed them, and the fifth and final session was devoted to a paper on "The Assessment of the Work of a Research Laboratory," by Mr. A. H. Wilson, director of research and development, Courtaulds, Ltd.

This question of the "creativity" of the scientist, discussed in the second session, also occurred in various forms in later sessions, the greatest of the research problems, as *Punch* remarked, being the people who do the research. Scientific research in its higher flights has, in the past, largely been pursued by men who have been strongly individual in their outlook. Their main driving force has been an intense curiosity giving them a complete absorption in the problem being attacked and they have sensed something of that creative urge known to the poet and to the composer; one of the main problems wrestled with in the conference was that of recognising this creative ability when it appears and of infusing it into the activities of large groups. Although many of the problems coming to a large research organisation are metaphorically simply those of "baking better buns," it was emphasised that for long-term progress the organisation of a large research unit must be flexible and imaginative enough to recognise and even attract the creative mind, and to explore and develop the new idea.

Standards for the British Automobile Industry. Standards and Technical Department, Society of Motor Manufacturers and Traders, Ltd., 148, Piccadilly, London, W.1. Price 44s. (members) and 84s. (non-members); amendment service, 21s. p.a.

IT is hardly necessary to remark that this volume will be required by all engineers designing or building motor vehicles or components; it is worthy of note that it is particularly well presented in a substantial loose-leaf binder with provision for clamping the pages, and that the margins at the inside are adequately wide. This format, in conjunction with the system of sheet numbering adopted, gives promise of rendering the incorporation of amendments and additions easy.

This is, however, an occasion to observe the work of the Standards and Technical Board, and it appears that the Board has, as the Foreword states, confined itself to recording those standards which are already in common use. Thus we find standard gear shift patterns for three-speed but not four-speed boxes, close and complete specifications for dynamos and starters, but none for fuel pumps or carburettors. There are also noticeably few standards defining manufacturing tolerances—that for leaf springs is an exception—to ensure interchangeability between the products of different sources. It cannot escape observation that the S.A.E. Standards included, those for splines and shaft serrations, feature outstanding rigour, and must endow a larger scope for "Meccano" assembly than any others except, possibly, those for piston rings.

Although it is distressing to discover that the largest of all the specialist committees—that for tyres and wheels—has yet to bring its first specification to the stage of being indexed, let alone issued, we can be consoled by the fact that little is yet known of the performance of the most critical of automobile components, the tyre. This paucity of knowledge must be a serious handicap to the standardisation of size, shape and performance of an item often mixed in sets in which the only uniform characteristic is the nominal size marked on the wall.

If we turn to the non-ferrous metals sub-committee, whose standards for anodised aluminium body fittings are indexed but not issued, we observe that there is no committee member representing the suppliers of non-ferrous metals in a total of thirteen. Here is a field well looked after technologically with a wide field of established specifications already in use. The corresponding S.A.E. committee has manufacturers' representatives in each of its separate sections dealing with copper, aluminium, magnesium, and so on, whilst the standards themselves draw widely on the work of the appropriate A.S.T.M., A.S.M., and similar standardising bodies.

It would therefore seem that the policy of the ferrous metals sub-committee, in presenting a preferred range of existing standards rather than in deliberating at length in an attempt to agree on new standards, might well be followed by other sub-committees. This should enable reasonable standards to be established for raw materials, metallic and non-metallic, and so repair very sizable gaps in the present standards.

In the cases of complete components the requirements to be fulfilled by standardisation should basically answer the questions "will it fit?" and "will it work?" Whilst S.M.M.T. Standard No. 18 ensures that terminal posts and cable connectors will fit together there is no mention of the fact that they should also conduct electricity, or of the minimum contact resistances permissible. Similarly, S.M.M.T. Standard EL 10–1 shows a drawing of a 4in d.c. generator remarkably like the corresponding drawing in a well-known manufacturer's catalogue, together with that same manufacturer's performance data. All performance data are described as maximum and the potential user of the specification must agree with the supplier on the performance of a nominally "standardised" component.

When we note that all recommendations in this book are advisory only, and their use is entirely voluntary, we declare that this committee, and the Standards Board as a whole, would do well to get ahead of the game, to issue standards for those items which are at present produced in different forms, and thereby allow the purchaser to show whether or not he values adherence to some arbitrary code of practice.

It goes without saying that if a set of specifications is to be issued it should be written in a form which will command general respect, and if it should fail in this manner then the time and trouble taken to compile those standards will have been wholly wasted.

Heating and Air-Conditioning of Buildings. Third Edition. By OSCAR FABER and J. R. KELL. The Architectural Press, 9–13, Queen Anne's Gate, Westminster, London, S.W.1. Price 65s.

THIS is the third edition of a textbook that has long been accepted as a standard reference work by heating engineers and architects. For reasons that are well known, greater efficiency in the use of fuel for space heating is becoming increasingly important

with an urgency that calls for an authoritative presentation of the many new developments in methods and equipment. The reader may turn to this new edition, revised and extended with an emphasis on plant and equipment, for an up-to-date account of these developments without being overburdened with highly technical considerations. More references, however, could usefully have been given to research and other specialised papers that have appeared since the second edition was published in 1943. Whenever possible, reference to original papers should be encouraged. Very little has been added to the earlier chapters on fundamentals, but a particularly noteworthy addition deals with the report entitled " Basic Design Temperatures for Space-Heating," published in 1955 as Post-War Building Study No. 33. This document, which is particularly useful for its analysis of meteorological data, was prepared by a committee set up in 1950 to make proposals for the selection of basic design temperatures for space-heating. The authors have summarised the principal findings of the work of this committee in a table giving suggested design temperatures for eight regions representing the populous areas of Great Britain and Northern Ireland. Basic design temperatures involve considerations of the thermal capacity of buildings and introduce complex problems in variable heat flow. Some developments in methods of obtaining practical solutions to certain of these problems have been described in recent years, but the authors' earlier empirical treatment of the subject remains unaltered in this new edition. Calculation of solar heat gains in air conditioning might have been treated more effectively by introducing the concept of sol-air temperature. Units of heat transfer as expressed in British Standard 874 : 1956, " Definitions of Heat Insulating Terms and Methods of Determining Thermal Conductivity," do not appear in this revision. A consistent terminology is very desirable in publications.

To sum up, the quality of the earlier edition is maintained in this new volume and the additional information brings the work up to date for engineers and architects.

Tin Box Manufacture. By J. W. LANGTON, M.B.E., B.Sc., M.I.Mech.E. Canning Publications, Ltd., 14–15, Coleman Street, London, E.C.2. Price 30s.

THE author states that his object in writing this book is to pass on to young entrants to the tin box trade the basic facts of the manufacturing processes which have not hitherto been readily available from a single volume. The book describes the production of seamless and made-up containers of round, rectangular and irregular shapes. It deals step by step with the processes, tools and machines from the initial stages of cutting and testing of tinplate to the soldering and testing of the finished containers.

Books Received

A Further Handbook of Industrial Radiology. By W. J. Wiltshire. Edward Arnold (Publishers), Ltd., 41, Maddox Street, London, W.1. Price 50s.

Progress in Semiconductors. Volume 2. By Alan F. Gibson. Heywood and Co., Ltd., Ingersoll House, 9, Kingsway, London, W.C.2. Price 63s.

Transmission Circuits. By Everard M. Williams, and James B. Woodford. The Macmillan Company, 10, South Audley Street, London, W.1. Price 30s.

The Prospects of Nuclear Power and Technology. By Gerald Wendt. Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 42s.

An Introduction to the Cathode Ray Oscilloscope. By Harley Carter. Cleaver-Hume Press, Ltd., 31, Wrights Lane, Kensington, London, W.8. Price 12s. 6d.

Obituary

RICHARD RAPIER STOKES

MR. RICHARD RAPIER STOKES, M.P., died in London on August 3, at the age of sixty. He had broken three ribs when his car overturned in a ditch on July 21, and had been ill with bronchitis since the accident. Mr. Stokes was born on January 27, 1897, and was the second son of a barrister, Phillip Folliot Stokes. He was captain of the school at Downside, the first under the newly introduced prefectorial system. His uncle was the inventor of the Stokes mortar, and the young man saw the weapon in use while serving with the Royal Artillery on the Western Front in the war of 1914–18. He won the M.C. with bar, and the Croix de Guerre, and was gazetted major when twenty years old. After obtaining his degree and a Rugby Blue at Trinity College, Cambridge, he entered the family business of Ransomes and Rapier, Ltd., and became its chairman in 1927 at the age of thirty. In addition, he was managing director both of Ransomes and Rapier, Ltd., and of Cochran and Co. (Annan), Ltd.

But as well as being an industrialist, Mr. Stokes was a prominent politician. After joining the Labour Party he contested Central Glasgow, but suffered defeat. He won Ipswich in a by-election in 1938, however, and retained it for the rest of his life. Outspoken and without fear, he would say what he thought, with forceful clarity, and, in spite of his good humour, he would pay little regard to any embarrassment he might cause. He was active in opposition to the Coalition Government all through the war years, and was particularly critical of the situation that arose over the supply of tanks. He criticised the Labour Government of 1945–50 with equal vigour when he differed on policy, notably in connection with the Middle East, the American loan, and the administration of Western Germany. In 1950, R. R. Stokes became Minister of Works ; he was appointed Lord Privy Seal in April, 1951, and Minister of Materials in July of the same year. In the latter capacity he was sent to negotiate with Dr. Mossaddek when the Persian oil crisis arose. The apparent failure of this mission was never attributed to the fact that Stokes was the emissary, and it was generally agreed that he performed his task as well as anybody could have done. He was certainly a unique member of the Labour Cabinet, a business man possessing both wealth and ability in full measure. His last charge was to set in hand and fulfil an armament programme the projection of which had led to two Cabinet resignations, those of Mr. Aneurin Bevan and Mr. Harold Wilson. The Government fell shortly afterwards, and it has been suggested that Stokes lost the chance to prove himself in a commission upon which he had entered with energy and skill. Last autumn he was defeated in elections for the Labour Party's " shadow Cabinet," and a few months ago he was associated with Sir Hartley Shawcross in public criticism of plans for further nationalisation.

Throughout his political career, Stokes enjoyed the role of the hard-hitting critic, though he always delivered his blows without malice ; essentially he was a generous and likeable man. He won a reputation for efficiency during his ministerial days, and the Conservative opposition recognised this—not without allusion to its supposed origin in his business experience. His brief stay at or around the summit did not spoil him, and he is said to have claimed never to have been other than " a back-bencher at heart." He fretted under political discipline, and did not suffer gladly the restraint of the party line. A deeply religious man, he was alone in his protest against the bombing of Cologne during the last war. He had distinguished himself in the field in 1914–18, but he returned from the war with a deep and lasting hatred of it. His generosity coloured both his public and his personal relationships. When rearmament was first suggested by the Government in the early 'thirties, Stokes offered that all work by his firm for this purpose should be done at no more than cost price. It was, however, an offer that was rejected.

H. H. JOHNSON

WE have learned with regret of the death of Mr. Herbert Henry Johnson, which occurred on Saturday last, August 3, at his home at Harpenden, Herts. Mr. Johnson, who was eighty-two, served for many years on the editorial staff of our contemporary, *Engineering*, and was a joint editor of that journal from 1924 till 1939.

Mr. Johnson was educated at Merchant Taylors School and at the University of Liverpool, where he became a Derby scholar. His apprenticeship was served in Liverpool with Arrowsmith, Sinclair and Co., and thereafter he spent some years in the drawing-offices and design departments of Poyser, Heywood and Acland, in Nottingham ; Ferranti, Ltd., Hollinwood ; and the British Westinghouse Electric and Manufacturing Company, Ltd., Manchester. His long period of service in technical journalism began in 1909 when he was appointed to the editorial staff of our contemporary. It was a service that had to be interrupted by the demands of the first world war, during the greater part of which Mr. Johnson was engaged as assistant works manager at the National Projectile Factory in Lancaster. When the war ended, he resumed his work with *Engineering* and, as already stated, became joint editor in 1924. Although he retired from the daily tasks of his office in 1939, Mr. Johnson by no means relinquished his long and active association with our contemporary, for right up to the last he remained a member of its board of directors. As is the way of technical journalism, we frequently found ourselves, in the pre-war years, at meetings and works visits attended by Mr. Johnson ; his friendliness, combined with the breadth of his knowledge, will not be quickly forgotten.

Mr. Johnson was a member of the Institution of Mechanical Engineers and of the Institution of Electrical Engineers. He gained a Whitworth Exhibition in 1898, and for many years had taken a prominent part in the work of the Whitworth Society. He served as president of the Society in 1950–51.

L. K. BRINDLEY

MR. L. K. BRINDLEY, whose death occurred on July 29, was a consultant to the president of the International Nickel Company of Canada, Ltd., and until last February was deputy chairman of the Mond Nickel Company, Ltd. Mr. Brindley joined the Mond Nickel Company, Ltd., in 1948 and became a director in December of that year, managing director in January, 1951, and deputy chairman in May, 1955. Mr. Brindley was born in Dublin in 1887.

Hypersonic Researches

The Armament Research and Development Establishment is carrying out experiments with "cold" and "hot" hypersonic tunnels, with a launcher able to endow a model with speeds up to 10,000ft per second, and with a low density tunnel running in the slip flow regime. The plant and the principles of operation are briefly described here.

THE prospect of launching ballistic missiles of exceedingly long range and correspondingly high trajectories has drawn much attention to the investigation of hypersonic flow and of superaerodynamics. The Armament Research and Development Establishment, Fort Halstead, has built a variety of plant to reproduce the phenomena associated with the extremes of speed and altitude. This includes "cold" and "hot" hypersonic tunnels driven by a pressure tube and a light gas gun, respectively, a high velocity launcher, in which a model is fired along a range by a light gas gun, and a low density tunnel running at vacua down to about 10 microns Hg.

Pressure Tube Tunnel

The principle of the pressure tube tunnel was originally proposed by Ludwieg at Gottingen as a simple tool for work at supersonic speeds : the method will be set forth briefly for comparison with the more advanced techniques. A reservoir of gas in the form of a very long tube is connected

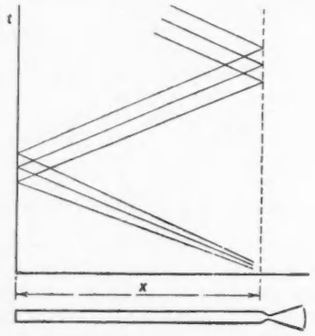


Fig. 1—Discharge of reservoir of pressure tube

through a supersonic nozzle to a working section, and discharges through a diffuser : the diffuser is sealed off by a diaphragm and the whole volume pressurised. When the diaphragm ruptures, expansion waves pass through the working section and nozzle into the tube, and gas accelerates in the opposite direction. This process ends when the nozzle chokes, and conditions at the downstream end of the tube then remain steady while the waves traverse the tube to the closed end and return (see Fig. 1). There is then a drop in pressure at the nozzle followed by another interval of steady flow whose duration is determined by the length of the tube (see Fig. 3). This will continue until the pressure is inadequate to sustain the flow through the fixed nozzle and diffuser.

The Mach numbers that can be attained in such a tunnel are limited by the need to avoid liquefaction of the working medium, and thus, while they may be high for helium, they may not exceed 4 for air expanding from room temperature. The extent to which the performance can be increased by heating the gas in the tube is limited by the properties of the pressure vessel : while only the gas near to the nozzle actually leaves the tube, it must be expected that if only this part of the charge were heated expansion waves would be reflected from the mass having a temperature gradient.

The open end of the pressure tube at Fort Halstead is seen in Fig. 2 : there are glass windows in the sides of the working section for schlieren visualisation. Steady flow has been maintained in this tunnel for periods of nearly

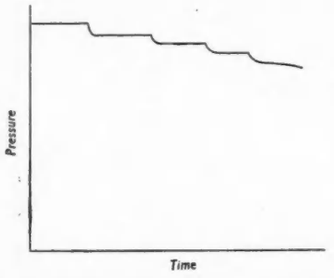
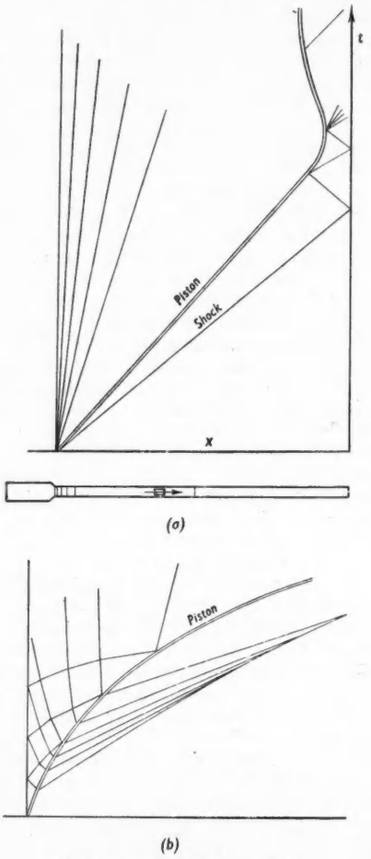


Fig. 3—Pressure above nozzle of pressure tube

60 milliseconds. Experiments have been made with a long, flexible hose as the reservoir, in order to reduce the space needed to house the device ; contrary to expectation, no degradation of performance due to reflections off the walls was detected.

Light Gas Gun Tunnels

A high-temperature store of air for the operation of a tunnel can be made available by utilising the discharge of a light gas gun. This consists of a large reservoir of gas under high pressure, separated by a diaphragm from a barrel within which moves a light piston. The diaphragm is ruptured with the piston at the near end of the barrel, accelerating the piston violently and setting up the pattern of compression and expansion waves shown in the detail of Fig. 4. The piston rapidly reaches a nearly constant speed defined by the Mach number at which the pressure behind the shock fronts is equal to that in front of the pressure waves and, clearly, higher for light than for dense gases, and passes along the barrel until, nearing the far end, it is met by a shock wave reflected off the far end of the barrel. Two or three reflections —more only in the case of a very heavy piston, which would not be expected to attain the desired speeds—stop the piston and it moves back to an equilibrium position. The passage of the reflected



(*a*) Motion of piston of light gas gun.
(*b*) Piston starting motion.

Fig. 4—Discharge of light gas gun

shock waves through the gas in front of the piston raises its temperature abruptly, theoretically to about 3000 deg. K in the case of air, 7000 deg. K for helium, and 10,000 deg. K for hydrogen (while these temperatures will be reduced by such phenomena as ionisation, subsequent expansion will be as from these levels). The pressure ahead of the piston fluctuates fiercely after it comes to rest, but in about 0·05 seconds settles down at a value close to the initial reservoir pressure. A diaphragm separating this space from a supersonic nozzle and the working section is designed to rupture at this stage, and the hot compressed gas is then used as working fluid for a run lasting in the order of seconds. The actual duration is determined by the ability of the nozzle to sustain the temperatures involved. In order that the theoretical flow in the divergent part of the nozzle shall be able to establish itself, it is in practice necessary to evacuate the tunnel downstream of the second diaphragm.

There are at A.R.D.E. two "hot" hypersonic tunnels employing this principle, one with a barrel of 20mm bore and the other 40mm bore. The larger is shown in Fig. 5 ; it has its reservoir screwed to the barrel, whereas that of the smaller and earlier tunnel is clamped to it by a normal gun breech mechanism. In order that the reservoir need not be discharged while replacing the diaphragm, a screw-down needle valve, operated by the handle seen beyond the reservoir, is provided. The reservoir has a capacity of 1½ cubic feet and runs at about 250 atmospheres :

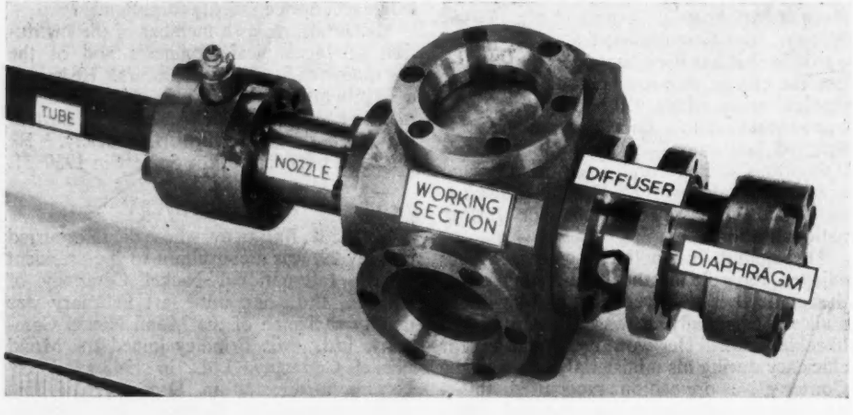


Fig. 2—The working part of the pressure tube tunnel ; steady conditions have been observed for over 50 milliseconds

there is provision for rupturing the diaphragm under electrical control instead of, as usual, by increasing the pressure. The piston is turned from nylon rod, and weighs about 10 grammes. The barrel may be pressurised to, say, 10 atmospheres initially, not necessarily with the same gas as the reservoir, and is seen fitted with instrumentation for pressure measurement. The nozzle throat is made of steel, for use at the moderate temperatures involved with air driving air, copper, for air as working fluid and helium or hydrogen driving, or tungsten for extreme temperatures : a $M=10$ nozzle might have a throat diameter of 0·060in. Running times envisaged for this tunnel range up to 1 second at 1000 deg. K and 0·1 second at 9000 deg. K. The nozzle expands at 7½ deg. included angle to 3in diameter to an open jet working section : above the section there is a microphone which provides a highly sensitive record of the sequence of events in the tunnel. Instrumentation is, of course, a matter of some difficulty in such hot gas streams, and thermocouples of 0·004in chromel-alumel wires are being used. A method of measuring velocity directly by creating a disturbance in the stream with a spark discharge, and taking spark photographs of the disturbance as it passes downstream, is being developed but is not expected to afford great accuracy. Pressure measurements are made by capacitor transducers.

Light Gas Gun Launcher

It was related above that severe fluctuations of pressure occur in front of the piston of a light gas gun when it has reached its final position. It has been observed that the peak pressures may exceed 25 tons per square inch, although the final pressure settles to 2 tons per square inch. This high transient pressure can be utilised by allowing it to accelerate yet another piston ; if this further piston is passing along an evacuated tube, velocities of 20,000ft per second may be attained. This piston can be formed by a model, or, possibly, a model and sabots, and be projected into a range on which its behaviour is examined.

Fig. 7 shows the launcher at Fort Halstead ; the reservoir at the right is 5in in diameter, the gas gun barrel is 1·000in, and the launcher bore is 0·250in, this final stage being about 200 calibres long. This example attains about 7000ft per second running on air, and 10,000ft per second with hydrogen as the driving medium and helium as the working fluid. The second piston or projectile is retained by a shear ring until the peak pressure is built up behind it. The projectile has to pass through a diaphragm to leave the evacuated volume and enter the range, but this need be no more than ½in in diameter and such a material as cigarette paper may be employed. The range may be pressurised to, say, 10 atmospheres in future work, and it is anticipated that the full-scale Reynolds numbers of, say, the re-entry case, will be achieved by this technique. The observation of the flight of the model is not expected to present difficulties to the A.R.D.E.

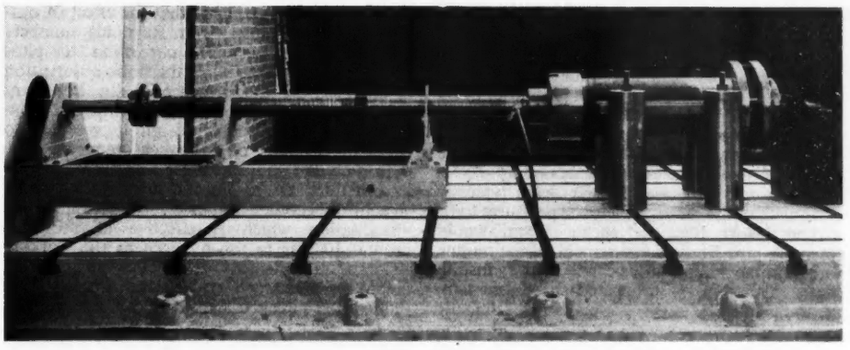


Fig. 7—The light gas gun formed by the first two sections of tube seen here is used to accelerate a projectile down the final barrel to 10,000ft per second. Within the building there is a range on which the path of the model can be observed

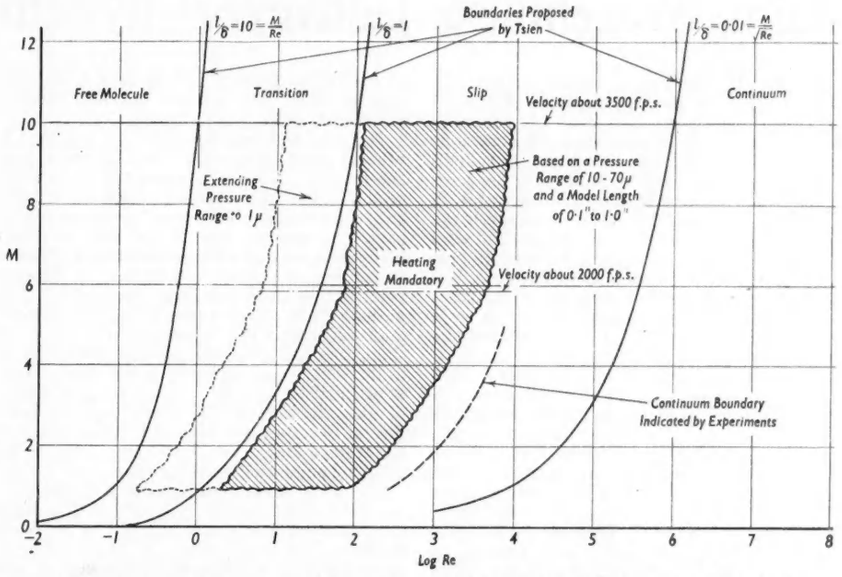


Fig. 8—Range of Mach and Reynolds numbers covered by the low density tunnel running on air

Low-Density Tunnel

Both aerodynamic and ballistic vehicles are now envisaged as travelling at such altitudes that the mean free path of the atmospheric molecules compares with the dimensions of the body, i.e. at Knudsen numbers of the order of unity. To study these conditions a low-density tunnel has been built ; its performance when running on air is illustrated in Fig. 8, which also shows a set of proposed divisions between the regimes of molecular and slip flow. For the higher speeds heating of the working fluid is necessary, but the mass flow is so minute that this presents no difficulty. The tunnel in its original form is seen

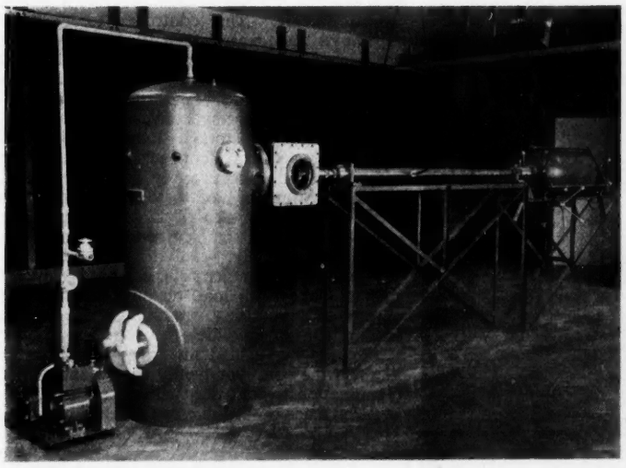


Fig. 5—The 40mm light gas gun ; at the far end is seen the pressure reservoir, screwed to the barrel. At this end of the barrel a nozzle leads to the working section, glazed for schlieren visualisation, which is connected to a vessel which may be evacuated by the vacuum pump in the foreground

Fig. 6—Projecting from the right-hand end of the working section can be seen the intake pipe connected to a nitrogen cylinder, and above it a thermometer. Pressure instrumentation occupies the working section. At the left-hand end are the diffusion and rotary vacuum pumps

in Fig. 6; gas is admitted through a needle valve to a working section which is continuously pumped. Steady conditions take many minutes to achieve, but running times are almost indefinitely long. The tunnel is now being rebuilt to employ at first two and later three diffusion pumps.

The technique of using such a tunnel presents many unusual features. The boundary layers on the nozzle will be extremely deep, typically two-thirds of the radius; were the pressures to be carried below 10μ, the entire stream would resemble pipe flow. Measurement of the minute forces on the model can be carried out by installing a balance in the evacuated space, but temperatures must be inferred by assuming adiabatic expansion in the core of the stream. Pressure measurements are made directly, but the apparatus must be so designed that the effect of outgassing is negligible. For Reynolds numbers below 200 an empirical correction to pitot pressures is required, while the static observation is confused by the presence of the boundary layer. Mach numbers have been inferred from temperatures and observed pitot pressures to check the accuracy of static measurements.

In such conditions as these a shock wave may have a thickness of $\frac{1}{4}$in and investigation of its structure becomes possible. A technique of visualisation which is effective at pressures around 100μ is to use nitrogen as the working fluid and raise its potential to 500V or higher by means of a charged grid in the nozzle. This renders the nitrogen transiently luminescent and changes in its density can be discerned. The illustrations to this article are Crown copyright.

Paint Warehouse Conveyor System

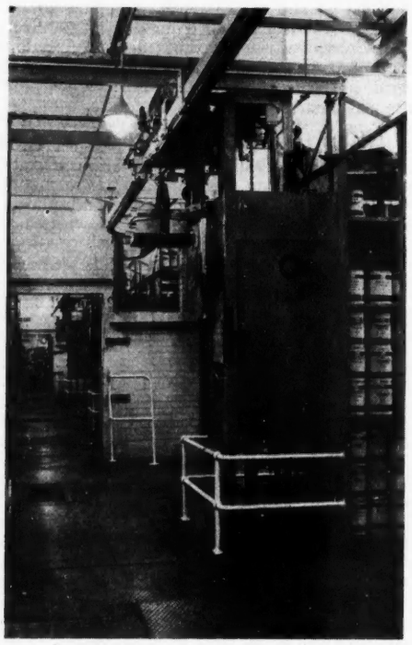
A PAINT warehouse recently placed in service at the Slough paint works of Imperial Chemical Industries, Ltd., is of particular interest both in its construction and the methods adopted for storage and handling. It is built on a site of only 400ft by 300ft and provides a storage capacity for a million gallons of paint, in the form of some 7000 stock items which are involved in the different types, colours and sizes of tins of the paints handled. In order to provide the necessary reception, storage and selective dispatch facilities the warehouse incorporates a comprehensive rack installation served by a conveyor system designed and installed by Geo. W. King, Ltd., of Stevenage.

The main storage rack system which is used for tins of one gallon and less is built as a composite four-tier structure supported through its vertical members directly on the main foundations and not on intermediate floors of the building. The vertical members of this 40ft structure also support three intermediate upper "floors," which primarily comprise steel walkways between the racks. The outer walls of the building are simply protective shells and do not carry any loads. In this rack installation, which was supplied by Constructors, Ltd., there are stored a complete range of paints for making up required order "parcels" of different colours and tin sizes. A section of the ground floor of the building is arranged for the pallet storage of paints supplied in bulk lots to other paint depots and large users, and the large drums and kegs of paint not suitable for rack storage which are handled by fork trucks.

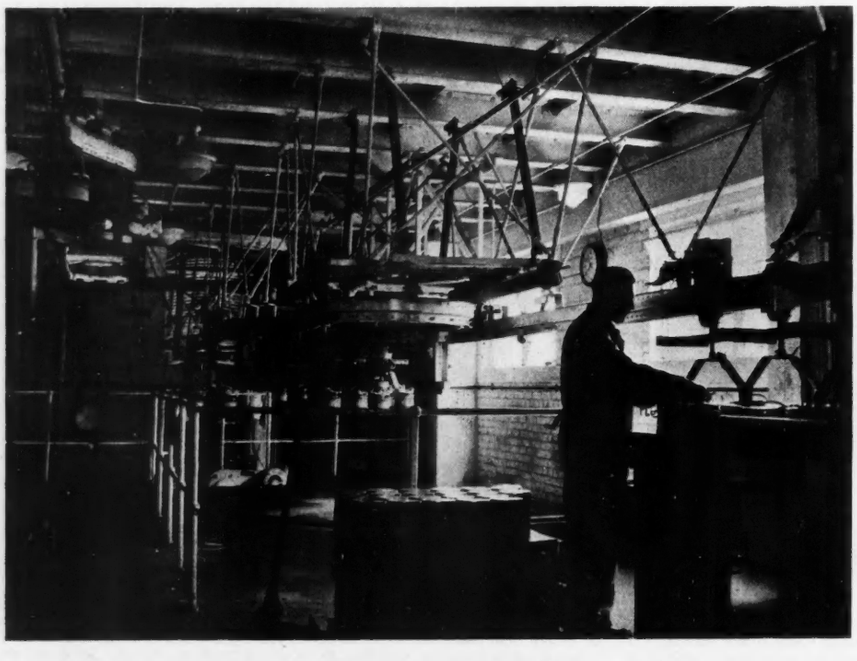
The shop in which the paint tins are filled is situated some 200ft away from the warehouse and the two buildings are connected by an overhead enclosed bridge, through which the delivery and return lines of a "Stanrun" conveyor system pass. At present this filling shop has two filling lines, each of which changes to a different size of tin at least once an hour and to a different paint colour somewhat less frequently. This means that at any one time three quite distinct kinds of product can be coming from the filling shop, each one being required on a different floor in the warehouse. Similarly in the warehouse it is essential to be able to dispatch components of the same order in haphazard sequence from several operators working in different parts of the storage area. Yet these must arrive at the checking points in definite sequence.

To satisfy these requirements a "Stanrun" overhead chain conveyor system with trolley-suspended trays has been installed in ten interconnected sections having a total length of some 3000ft. A particular advantage of this system is the means by which a tray can be transferred from one chain section to another at any of a number of predetermined points by the setting of keys on the supporting trollies. The conveyor chain speed is 40ft to 45ft per minute and each trolley is designed to support a load of 100 lb, which includes the weight of the tray and up to about 5 gallons of paint.

Tins of paint from the filling shop are loaded on trays at a reception station and the control key of each tray is set according to the floor at which its load is stored. At the appropriate floor each tray is automatically shunted off on to a reception circuit for unloading, and then passed back into the main system. One of these floor unloading stations can be seen in the illustration at the foot of this page. The tins are stacked in the racks according to type, size and colour, by hand. At the end of each line of racks on each floor there is a pneumatically operated transfer machine which removes an empty tray from the conveyor line and deposits it at a convenient loading level at a packing or assembly station. When the requisite tins have been loaded on to a tray it is reintroduced into the conveyor circuit. Each of these transfer operations is effected in about five seconds without interruption of the other trollies moving in the circuit. One of these loading stations at the end of a rack line can be seen in the illustration we reproduce above.



Loading stations along the main gangway of a warehouse floor



Emptying conveyor trays received from the filling department on a warehouse floor

The system is controlled from a central point by a "conveyor controller," who is linked to various parts of the warehouse by pneumatic tube systems, through which documents can be passed quickly. This controller receives and distributes the requirement notes which the order assembling operators use, and controls the work released in such a way as to keep the conveyor system balanced and running smoothly.

The main circulating conveyor passes along each of the four storage floors and into the dispatch area, where it connects through transfer machines to eight short conveyors called marshalling lines. For each of these marshalling lines there is one assembler working in the storage area, and each assembler sends his conveyor trays to his line only.

When an assembler has collected sufficient tins to make up a load he puts them into an empty conveyor tray waiting in the nearest loading station, of which there are six on every floor. Having loaded the tray, he adjusts the keys on the conveyor trolley to the appropriate combination so that they will be selected by the transfer machine at the entry to his marshalling line. Upon a lever being pulled the loaded tray is then automatically elevated and put back into the main circulating conveyor. The next empty tray is then selected by the loading station automatically and brought down to loading level. The main circulating conveyor is thus transporting on the single track filled trays from operators

throughout the storage area, all destined for one or other of eight marshalling lines.

From the marshalling lines the controller releases the trays one line at a time into a transfer conveyor, from which they finally pass into one of three storage loops for the subsequent operations of checking and packing. Two of these loops, accommodated in the roof of the building, each provides storage for 100 trays awaiting checking and packing. One loop delivers trays of goods for packing to an unloading point on the ground floor and the other loop delivers trays of goods which do not require packing to an unloading point at first floor level. The third loop, which has storage for only twenty-five trays and is used for small orders, is able to discharge on either ground or first floor levels.

Tins removed from the conveyor trays are checked on roller conveyors before being placed on a stillage or a mobile rack or allowed to proceed along the roller track to the packing point. Here cartons of the required size made on the floor above are fed down a system of chutes to tin loading stations. The completed orders are taken on slat conveyors to vehicle loading bays.

Free-Piston Engine Progress

THE Pescara free-piston engine system is at present the subject of widespread activity in this country, and progress in its introduction has recently been revealed by the Brush Group. The Brush Electrical Engineering Company, Ltd., has evolved a range of turbines for use with this system ; they have nominal horsepowers of 1000, 2000, 3000, 4000, 5000, 6000, 8000 and 10,000, at, generally, descending speeds. Units of 6000 h.p. and over are available for direct drive of 60-cycle alternators and of 8000 h.p. and over for 50-cycle alternators ; 3000 r.p.m. machines have eight stages and the remainder five. The turbine design reflects the low temperature and low pressure ratio involved, about 4 atmospheres and 450 deg. Cent ; the makers observe that it resembles a back-pressure steam turbine. The blades of each row are the same section and vary no more than 2 : 1 in length, being designed on free vortex assumptions. Pressure losses are minimised by a volute entry and a diffuser at the exit annulus. The rotor is virtually solid, but to permit more rapid starting provision is made to pass hot gas through the central bore. The gas enters through radial drillings just before the first stage blading and leaves through passages emerging just beyond the drum ; it comes out between two sets of glands, so that control of the flow is exerted by the pressure in this space. The opposite end of the drum is also between two sets of glands, so that the pressure on it can be used to balance end thrust. The rotor heating flow is not allowed to reach the vicinity of the bearings.

The construction is kinematic, as on axial-flow Brush steam turbines. The rotor is located axially at the inlet end by a self-aligning Michell bearing. Non-touching carbon seals form the glands, and labyrinths are provided to maintain tolerable end thrusts and gas escape rates in case of a carbon seal failing. The top halves of inlet, cylinder, and exhaust casings can be removed all together for inspection.

The National Gas and Oil Engine Company, Ltd., has completed preliminary trials of what is claimed to be the first S.I.G.M.A. G.S.34 gasifier of British manufacture to run. With the exception of the mechanical lubricator, no parts or components were imported, but complete interchangeability with the original units has been maintained. Our illustration shows the principal moving parts in the maker's works ; both compressor and engine pistons have three lead-bronze bearing bands, and there are two and six piston rings respectively. The synchronising linkage is also shown ; to maintain balance, the longer rod is partly hollow. The fuel pump is driven by the splined shaft from the short link, and the lubricator by the gear wheel attached to the long link. The hole near t.d.c. in the compressor piston surrounds the tube which unites the cushion volumes and prevents rotation of the pistons.

The British unit has a fuel pump and standard injectors made by Bryce Berger ; it uses Shell free-piston engine oil for the total loss feeds, and normal S.A.E.20 for the piston cooling and governor circuits (see page 106, July 19). The original engines, for which a licence in this country is held by Alan Muntz and Co., Ltd., were described on page 615, June 1, 1956.

Pumps for the Auxiliary Fire Service

PARTICULARS have been issued by Sigmund Pumps, Ltd., Team Valley, Gateshead, 11, of a single-stage centrifugal pump which has been developed and is now being made in large numbers for the Auxiliary Fire Service in this country. One of the pumps as fitted on a fire tender can be seen in the illustration below. The pump is driven directly from the 100 h.p. engine of the tender at 3000 r.p.m. and is designed to achieve the specified full output of 900 g.p.m. on a 10ft lift working with a 5½in suction hose. It can be primed on suction lifts up to 25ft in nineteen seconds using an integral self-priming piston pump. Each of the pump's twin discharge branches is fitted with a breeches piece so that four hose connections are available. A 6in full-bore outlet fitted with a non-return valve can be used in conjunction with 6in hose for relay pumping when required.

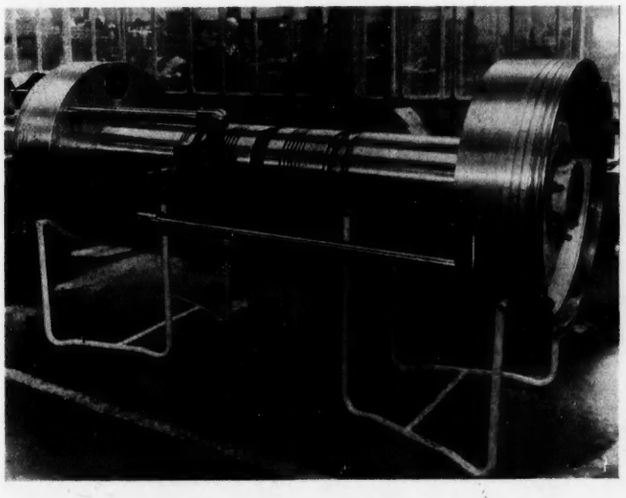
The pump has a body and suction cover of gun-metal, and its gun-metal impeller is keyed on to a stainless steel spindle carried in two single-row ball bearings. The spindle gland contains four turns of packing, fitted in pairs, and between the pairs is a lantern ring to which grease is fed by a screwdown lubricator. The method of tightening the gland has been simplified : the gland is held against the packing by a hinged lever, passing through the ports in the housing, and it is adjusted through this lever by turning a handwheel on an extended screwed stud. Within the gland the spindle is protected by a bronze liner, seating against a shoulder on the spindle and secured by the impeller boss.

The single-sided impeller has a balance ring on the back. It runs in renewable wear rings in the pump body and the suction cover, and discharges through a diffuser ring into the pump volute. The suction branch, of gun-metal, attached by studs to the centre of the suction cover, is fitted with a strainer.

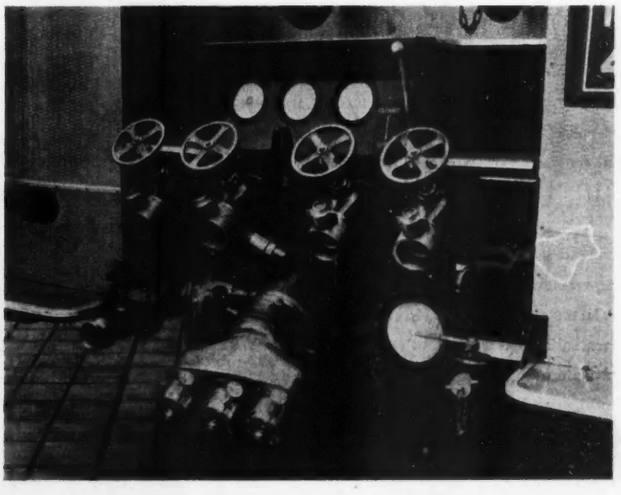
On the top centre of the suction cover, above the suction branch, there is a cored facing to which the priming pump suction is connected. The priming pump has two horizontally opposed cylinders and is mounted at right angles to the spindle of the main pump, above the bearing housing. It is held in position laterally by lugs which can slide on two pillars, connected at the top by a bridge piece, but is flexibly mounted in the vertical direction, the lugs resting on coil springs. At the rear end it is held by the suction connection, in which the necessary flexibility is provided by a double bend and a bellows piece. The drive is by friction from a grooved pulley on the main pump spindle to grooves on the priming pump flywheel, and it gives a 2 to 1 reduction. The flexibility of the priming pump mounting is sufficient to enable the drive to be pulled into engagement by means of the priming lever, and the springs on the locating columns ensure full disengagement when the lever is pushed forward to release the drive. Operation of this lever also opens and closes an atmospheric valve on the priming pump suction, which enables priming to begin and shuts off the priming pump suction from the main pump suction when normal flow has been established. The normal priming speed is 1000 r.p.m.; 1500 r.p.m. must not be exceeded and is indicated by a red line on the dial of the revolution counter.

Adjacent to the revolution counter are the suction and delivery pressure gauges. The delivery gauge reads from 0 lb to 250 lb per square inch, and a compound gauge is fitted on the suction, reading vacuum from 0in to 30in of mercury and pressure from 0 lb to 150 lb per square inch.

The pump can be used also for projecting foam, for which purpose provision is made on the suction and delivery for connecting a multi-jet foam inductor, without the need for adaptors. The drive from the engine of the vehicle is through a transfer gearbox and transmission shaft, which is connected to the pump spindle by a Hardy-Spicer coupling. When the pump is being driven for long periods additional engine cooling is provided by a heat exchanger fitted under the radiator. This exchanger consists of a closed circuit system in which water is supplied from the delivery side of the pump and returned to the suction side. There is also a by-pass in the piping to cool the oil in the engine sump.



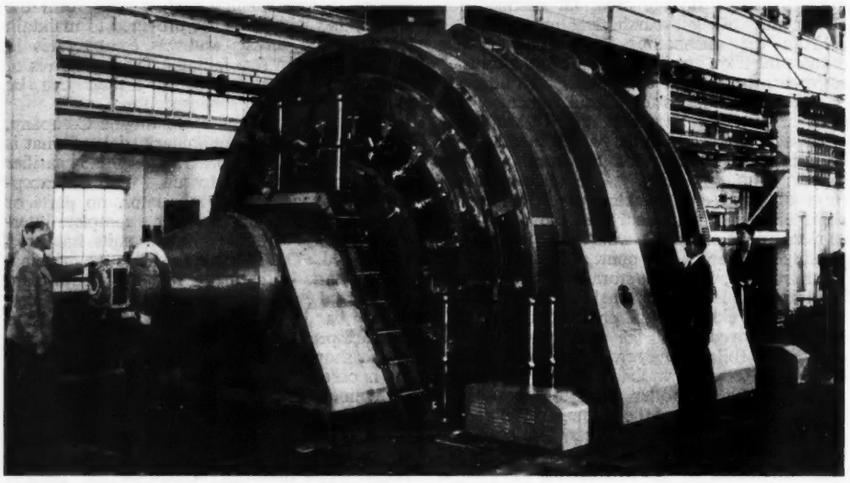
The main moving parts of the gasifier

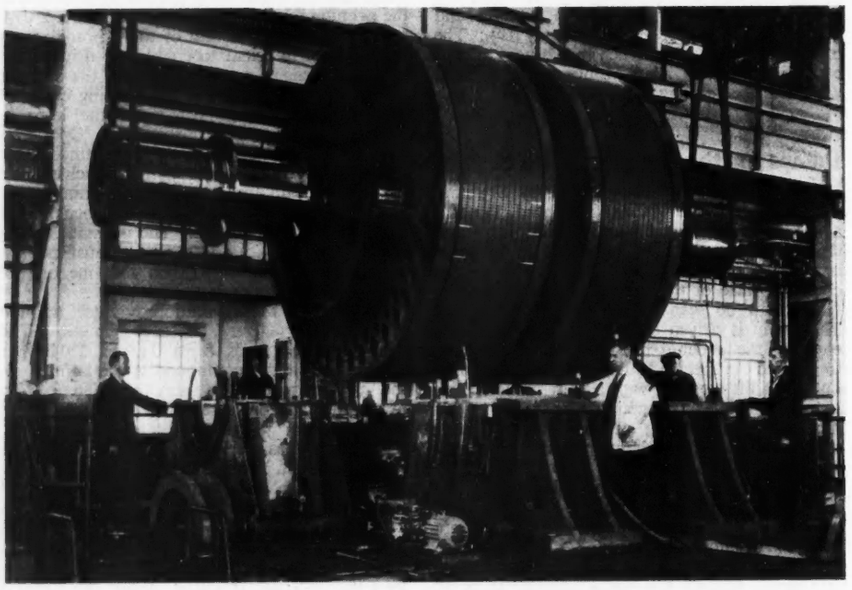


Heavy duty fire pump fitted in an A.F.S. fire tender

Rolling Mill Motors

We illustrate here two large d.c. rolling mill motors recently manufactured in British works. One of these was built at the Rugby Works of the British Thomson-Houston Company, Ltd. It is rated at 7000 h.p., running at 50/100 r.p.m., with a peak capacity of 21,000 h.p., and is designed for driving a 43in reversing cogging mill at the Templeboro Works of Steel Peech and Tozer, Ltd. The motor will replace a B.T.H. machine installed in 1919 and still running. The flywheel motor-generator set for supplying the new motor was installed in December, 1956, and the new motor will be installed during the coming August.

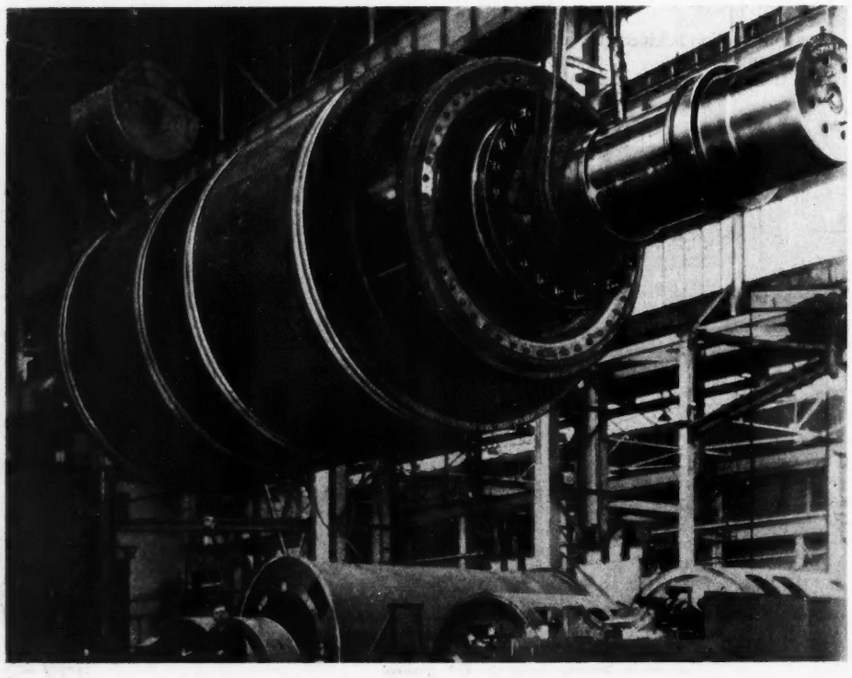




Its associated control gear embodies up-to-date amplidyne control designed to give high rates of acceleration and retardation combined with accurate peak load limitation. The illustration above shows the motor on test at the B.T.H. works, when it was subjected to peak loads of three times normal full load at full voltage and maximum speed without any sign of sparking at the brushes. The armature for this motor weighs over 100 tons and the illustration on the left shows the armature being lifted during the process of dismantling the machine after testing. It is a double-unit armature without through shaft, the two units being bracketed together at the centre. This construction enables the armature to be split for ease of transport and erection, and the manufacturer has designed and supplied a special lifting beam to facilitate handling during erection.

The second motor is one of three similar machines being manufactured in the Trafford Park Works of Metropolitan-Vickers Electrical Company, Ltd. Our final illustration shows a double armature for one of the three 8000 h.p., 65/130/160 r.p.m., d.c. reversing motors. These motors are being supplied for the new universal beam mill installation at the Lackenby Works of Dorman Long (Steel), Ltd.

Each of the three motors has an emergency operating peak rating of 24,000 h.p. and the commutators are designed for a current of 8000A. The motors have closed circuit cooling, with forced ventilation and cooling for the commutators. The armatures are 9ft in diameter ; the overall length of the double armature is 35ft 6in and the weight is 98 tons.



45-Ton Rail Crane

A RAIL-MOUNTED crane now being manufactured by Steels Engineering Products, Ltd., Sunderland, is designed to lift 45 tons at a radius of 12ft when fitted with a 50ft centres jib.

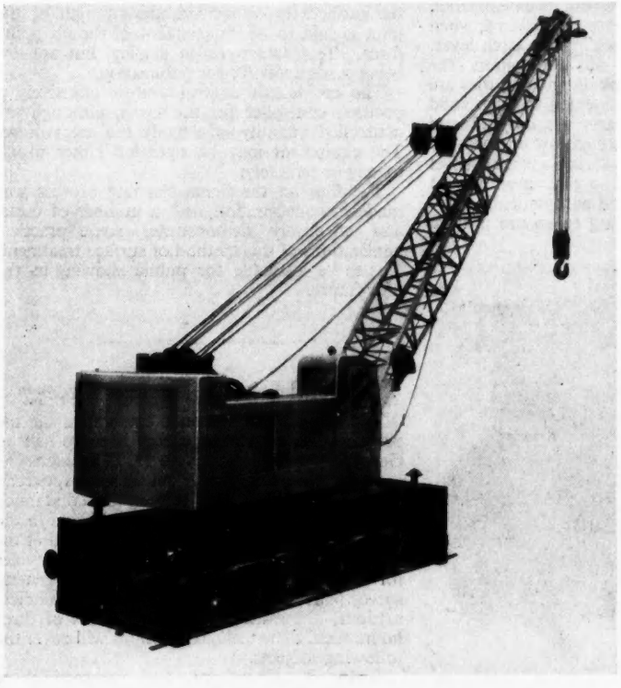
The power plant of this crane consists of a 100 h.p. diesel engine driving a shunt-wound generator which, in turn, supplies current to separate motors for each of the four crane motions of hoisting, derricking, slewing and travelling. As in other "Coles" cranes, an advantage of this transmission system is the resulting reduction in fuel consumption since the engine is not kept running at constant high speeds, power being developed according to needs whilst the crane is in use. In the event of the supply of current being interrupted, electro-mechanical brakes are automatically applied to the crane motions.

The controls in the operator's cab comprise finger-tip directional levers for each motion. Each lever is spring-loaded to its off position and the electro-mechanical brakes take control immediately the current drops.

The chassis frame of welded rolled steel sections and plates is mounted on two four-wheeled bogies each of which is driven by a separate electric motor.

The standard strut jib is of lattice construction, made in two sections of combined total length 50ft, which can be increased to 80ft by the use of extension pieces. For cranes with twin hoisting drums a 25ft fly-jib may be used as a straight extension or swan-neck with a maximum offset of 6ft from the centre line of the main jib.

When fitted with standard jib, as shown in the illustration below, the crane weighs approximately 84 tons, and it has a shunting capacity of 400 tons when working on a straight, level track. When required, the crane can be fitted with an electro-magnet of up to 50in diameter and for grabbing duties an assortment of grabs are available with a maximum capacity of 45/36 cubic feet, a spring-loaded tagline being provided for extra control. The safety equipment fitted includes a radius indicator which shows at a glance the safe working load for the jib radius, and any tendency to overload is immediately corrected by a "Coles B" and A" safe load indicator which gives both visual and audible warning signals. Totally enclosed, self-resetting limit switches provide an automatic safeguard against over-winding, over-lowering and derricking beyond the prescribed limits.



Rail crane with 100 h.p. diesel-electric drive designed to lift 45 tons at 12ft radius

Lightweight Subway Cars in Toronto

A FILM recently shown in London at the offices of the Aluminium Development Association deals with the construction of the aluminium subway cars built by the Gloucester Carriage and Wagon Company, Ltd., for the Toronto Transit Commission. Orders for the rolling stock of this new underground railway were placed in 1952. The initial order called for 104 passenger cars of steel construction except for a number of fittings such as entrance doors, seat frames, windows and interior mouldings, which are of aluminium. On the results of a study initiated by the Aluminium Development Association with the Toronto Transit Commission and the Gloucester Railway Carriage and Wagon Company, Ltd., it was decided to build a few cars with all-aluminium body shell structures in order to test the economics of light metal construction under actual service conditions. Eventually, six aluminium and 100 steel cars were built under the initial contracts, the aluminium cars being some 10,000 lb lighter than those of steel.

The steel and aluminium cars were built to identical design requirements and provided with the same traction and other equipment, the exterior of the steel cars being painted red, the aluminium cars having a bare metal, unpainted finish.

The aluminium cars, completed somewhat later than the steel ones, were put in service in March, 1954. Since then, careful measurements have been made continuously in both steel and aluminium cars of energy consumption, axle bearing wear, brake shoe and tyre wear, and data has been collected on maintenance of body shell finish.

An interesting paper giving a comparison of the service results with the steel and aluminium cars was presented to the American Institute of Electrical Engineers by Mr. L. W. Bardsley this year. This paper gives details of comparative tests on certain components and operating cost areas where definite savings might be expected from the aluminium cars. Four steel and four aluminium vehicles were used in the tests. It was calculated that the power consumption under certain typical conditions would be 4·8kWh per car-mile for the steel vehicles and 4·4kWh for those of aluminium construction, a power saving of 8·3 per cent. To check these figures by measurement eight watt-hour meters were mounted in each of the four-car trains to measure tractive power consumption, and over a long period they showed that the calculated and measured power consumption figures were identical. This saving of 0·4kWh per car-mile represents an annual saving of some 278 Canadian dollars.

In connection with journal bearings on the cars it was calculated that there would be an annual saving of some 28 dollars on each of the lightweight cars compared with the steel cars. Brake shoe life was considered and it was estimated that on the aluminium cars it would be 1·24 times that of the steel cars. Actual tests in service showed that the figure was 1·214, and the annual saving per car was some 109 dollars. The effect of weight reduction on wheel and track wear was difficult to determine, but experience indicated that the wheel replacement costs of the lightweight cars would show an annual saving of 50 dollars per car. A further saving of 66 dollars per year was effected as the aluminium cars did not require repainting as did the steel vehicles. Summarising the figures, the paper states that although all the possible savings had not been included, each of the aluminium cars would show a total annual saving of 531 dollars as compared with those of steel construction.

Standard Rail Tank Wagons

AT a recent exhibition in London, Charles Roberts and Co., Ltd., Horbury Junction, Wakefield, showed three four-wheeled standard tank wagons for the conveyance of bulk liquids at high speeds which have been designed to comply with the recommendations of the British Transport Commission. These vehicles, one of which we illustrate below, include a class "A" wagon for inflammable liquids, a class "B" wagon for heavy liquids and chemicals and fitted with steam heating coils, and a British Railways creosote tank wagon. They have been designed basically on a 15ft wheelbase, with length over headstocks 23ft 8½in and overall length 27ft 9½in, to comply with the ratio of wheelbase to length over uncompressed buffers of 0·54. All three vehicles have similar underframes of riveted construction and in which the main members are of rolled steel channel with $\frac{5}{16}$in thick top and bottom gusset plates at the ends of the frame and at the cross members.

The tank barrels are of butt welded construction, the ends being dished and flanged $\frac{3}{8}$in mild steel plate. The circumferential shell plates are of $\frac{1}{4}$in thick mild steel, except at the tank anchorage, where the thickness has been increased to $\frac{7}{16}$in. The class "A," class "B" and creosote vehicle barrels have gross capacities of 6149 gallons, 5370 gallons and 4880 gallons respectively. The variation in barrel size is caused by the maximum volume of liquid at various specific gravities that can be carried within the maximum registered gross weight of 35 tons on rail. Each tank is secured to its underframe by four anchor angles and rests upon two pairs of mild steel supports, behind which doubling plates are welded to the barrel.

The short drawgear is fitted with international hooks and screw couplings. Rubber draw springs are fitted, and mild steel rocking washers inserted between the rubber springs and the frame knee permit lateral movement of the drawhook. Self-contained pneumatic buffers are fitted, two vehicles having buffers manufactured by Oleo-Pneumatics, Ltd., and one with those made by Dowty Hydraulic Units, Ltd.

The two private owners' wagons exhibited had wheels 3ft 1in diameter on tread with 2½in rims, the journals 4⅞in diameter being machined to suit either Skefko or Timken roller bearing

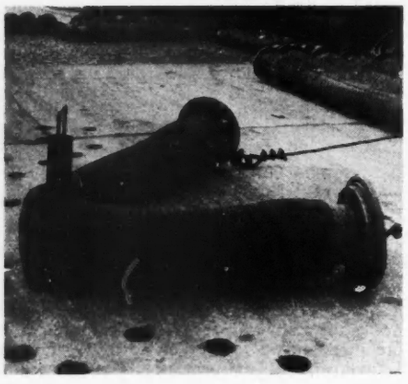
Tank wagon for the conveyance of class "A" liquids, fitted with roller bearings and vacuum brakes for express running

axleboxes. The British Railways creosote wagon is fitted with wheels 3ft 1½in diameter, 2¾in rims, and axles with journals 9in by 5in diameter to suit the " Isothermos " axlebox. These different axleboxes have been fitted in order to assess their behaviour under working conditions.

In addition to the regulation side hand lever brake, the wagons are fitted with automatic vacuum brake, utilising two 22in cylinders with direct admission valves, isolating cocks and empty/loaded change-over gear. The brake rigging is so designed as to use one cylinder when the wagon is empty, capable of exerting a total braking force of 90 per cent of the tare weight of the vehicle. By means of the manually operated change-over gear, the other cylinder may also be brought into action, thereby giving an augmented brake force of 66 per cent of the gross weight on rails.

Oil Discharge Hose

THE increase in the number and size of oil tankers and the correspondingly increased quantity of oil to be pumped has brought forward loading and unloading problems. For oil tankers the question of rapid turn-round is of considerable importance so that greater pumping capacity, higher pumping pressures and larger bore hoses are called for. To satisfy pressure and bore requirements means increased weight of hose and reduced flexibility, both of which create handling problems, the solution of which called for the development of high-pressure flexible hoses of a weight comparable with the conventional hose currently in use. These problems, together with the liability of hoses to



X.L. oil discharge hose undergoing kinking tests

distortion and kinking under the rough usage they receive abroad, have been the subject of research by the Dunlop Rubber Company, Ltd. As a result, the company has produced the Dunlop X.L. oil discharge hose which, it considers, is light in weight, strong enough to withstand the higher pumping pressures, resistant to damage by rough handling, and has a service life equal to the conventional hose.

The new hose is made from oil- and sun-resistant neoprene compounds, and has a soft wall so that it flattens under vacuum but without sustaining damage. Furthermore, the soft wall does not contain helices of steel wire and is highly resistant to damage by kinking. It is claimed that the weight is two-thirds of that of a hose, of the same bore and working pressure, constructed by conventional methods. The form of construction is such that the tendency to distortion when pressurised is controlled within fine limits, a maximum increase in length of 2 per cent being obtained at full working pressure. A prototype hose has been subjected, as shown in our illustration, to sharp kinking and release tests for 1000 cycles, without showing any sign of failure, and, when subsequently pressurised, successfully withstood a pressure of 1000 lb per square inch.

Eight-Electrode Spot Welding Machine

UP to eight welds can be made simultaneously using a multiple-electrode welding machine produced by Bates and Bates, Ltd., Garston, Liverpool. Standard superstructures can be attached for positioning the two 45kVA water cooled transformers and electrode holders, and there are available top and bottom platens ranging from the simple fixed arm to rotatable platens and conveyor-belt feeders.

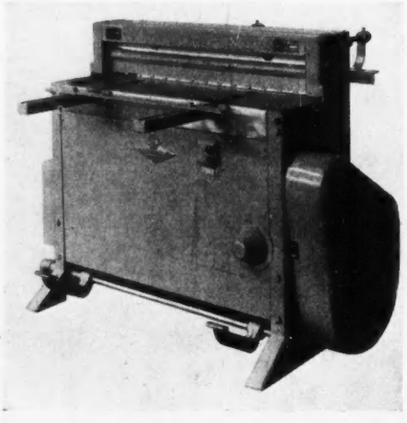
The electrode holders are hydraulically-operated, and the rams can be adjusted to give the desired pattern of eight spots. The maker claims that almost any pattern of welds can be made. Electrode loading is variable between 150 lb and 800 lb and is indicated by a gauge. Hydraulic pressure up to 1600 lb per square inch is obtained from an intensifier using air supplied at up to 80 lb per square inch. The transformers each have a five-position tapping switch for coarse adjustment of power—fine adjustment of power is electronically controlled. The secondary windings are water cooled. A bottom platen, 30in by 18in, may be fitted, and its height can be set in 2in steps. Alternatively, there is available a rotatable platen with three faces 20in by 18in, the height being adjusted by a hand screw. With this arrangement three different jigs may be used in turn. Switches change the electronic control settings when the platen rotates. Another standard unit can automatically feed a jig holder on to the bottom platen, permitting assembly of the work well clear of the machine. Two or more machines may fit closely alongside each other, making a continuous bottom platen.

The manufacturer states that with an automatic conveyor-belt work feeder it is easy to weld 19,200 spots an hour.

Power Guillotines

A NEW series of power guillotines introduced by F. J. Edwards, Ltd., of 359–361, Euston Road, London, N.W.1, includes three sizes of geared and one ungeared machine. The geared machines, which have a shearing capacity in mild steel of 16 S.W.G., are available in 3ft, 4ft or 6ft widths, and the capacity of the ungeared model is 3ft by 18 S.W.G. A trip latch box forming an integral part of the non-repeating, multi-tooth, dog clutch of these machines ensures single-stroke action even if pressure is maintained on the clutch pedal. Continuous stroke action may be obtained, when needed, simply by disconnecting the latch lever.

As can be seen from our illustration, the guillotines are of undercrank design, and they are constructed of steel plates welded to form solid members. All moving parts are covered and both the motor drive and clutch are enclosed by sheet metal guards. The spring-operated sheet hold-down fitted is slotted to give an additional view of the cutting line and automatically grips the material prior to cutting to ensure a clean accurate finish whilst effectively guarding the operator's hands.



Geared power guillotine for mild steel up to 16 gauge, made in three widths of 3ft, 4ft and 6ft

The rectangular section cutting beam is ribbed and welded to resist side stresses and is operated by two adjustable connecting-rods driven by eccentrics from the main shaft. Wear on the cutting beam guides is taken up by large adjustable bearing strips.

The flywheel is mounted on the main shaft on the ungeared machine and the driving shaft on the geared models. The ungeared machine operates at 120 strokes per minute, while the geared machine runs at 50 strokes per minute. The motor drives the flywheel through vee belts, and a spring-loaded brake, self-compensating for wear, is incorporated to damp the speed of the main shaft before the commencement and upon the completion of its cutting operation.

All of the guillotines are fitted for repetition work with easily adjusted standard back, front and side gauges, which enable parallel square and angular cutting to be achieved, and concealed strip lighting may be fitted to the machines to give a clear view of the cutting line.

Gas-Shielded Arc Equipment for Welding and Cutting

THREE processes using an inert-gas-shielded arc were recently demonstrated by British Oxygen Processes, Ltd. These were (i) rapid cutting and profiling of thick aluminium plate using a tungsten electrode and nitrogen shielding ; (ii) spot welding of thin steel sheets from one side only, using argon shielding, and (iii) continuous welding of variable-contour steel plates with automatic control of arc length, again using argon as a shield. The company's new colour film on its flame cleaning process was also shown.

The cutting machine operates from a power source of 110V (open circuit), giving arc voltages between 66 and 80. The constricted arc ejects a thin section of metal, and a clean-cut edge results. The maker states that thicknesses up to 1in can be dealt with using oxygen-free nitrogen or other suitable gases.

The improvement claimed for the spot welding process is greater consistency than has been obtained in the past. Cratering and cracking of the fused zone is avoided by a timing control which reduces the current to zero in four stages. The " spot " is slightly convex on the side to which the torch is applied. The torch is normally held in the hand, and, given good contact between the surfaces to be welded, the strength of the joint is said to be independent of the clamping force. Test data were on display, but are not being made available for publication.

The arc length control unit is effectively a position controller for the torch, although the controlled quantity is actually the arc voltage. The equipment may be operated either proximately or remotely.

The film on the flame cleaning process was made in collaboration with a number of users, and effectively demonstrates some practical applications of this method of surface treatment. It is to be available for public showing in the near future.

Peaceful Uses of Nuclear Energy

THE second international conference on the peaceful uses of nuclear energy is to be held in Geneva from September 1 to 13, 1958, inclusive, and the British Government has accepted an invitation to participate. It is expected that much information that has so far been withheld in the U.K., U.S.A. and Canada will be released at the conference. The provisional agenda provides for twelve plenary sessions embodying general survey papers and four parallel series of technical sessions, altogether sixty-eight sessions of three hours each. The technical sessions will cover the following subjects.

Series 1.—Chemistry and processing of irradiated fuel, reactor technology, radiation damage to reactor materials, handling of highly irradiated matter, treatment of radioactive wastes.

Series 2.—Nuclear physics, fission and fusion reactors, fuel cycles, economics, reactor tests.

Series 3.—Uses of isotopes and ionising radiation in various fields, dosimetry, biological effects of radiation and protection against them, reactor safety and siting, meteorological and oceanographical aspects of large-scale nuclear power production.

Series 4.—Raw materials, uranium and thorium production, isotope separation, fuel elements, material processing.

The conference is to be run on the same lines as the one held in 1955. The names of officials have still to be announced.

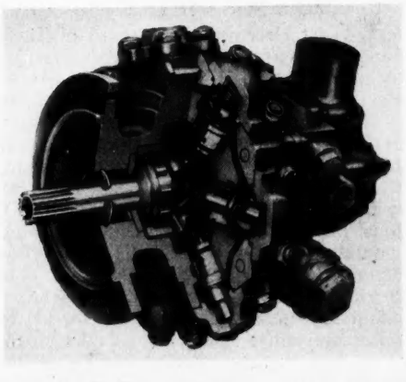
U.K. participation is being arranged by an executive committee under the chairmanship of Sir John Cockcroft. Independent persons or organisations wishing to contribute are invited to approach the papers secretary at the Atomic Energy Research Establishment, Harwell, Berkshire (titles and 500-word abstracts collected by the U.K. executive committee must reach the Secretary-General of the United Nations by March 1, 1958, and final texts by June 1, 1958). Other inquiries should be sent to the secretary of the Executive Committee at A.E.R.E., Harwell.

Industrial Hydraulic Pump

AN industrial model of the "Vardel" two-stage, self-regulating, high-pressure, hydraulic pump has been introduced by Dowty Equipment, Ltd., Cheltenham, for stationary, mobile and marine applications. This pump is available for pressures of 1000 lb to 4000 lb per square inch, outputs of 2½ to 5 g.p.m., and speeds of 1500 to 3000 r.p.m. It incorporates cut-out and relief valves so arranged that delivery automatically ceases when the set pressure is reached. It is stated that at 3000 r.p.m. "off-load" a pressure of 4000 lb per square inch is maintained by the pumps with a power input of under 2 h.p. All rotating parts of the pump are balanced to eliminate mechanical vibration, and its maintenance is simplified as all the wearing parts are interchangeable and readily replaceable.

The general construction of the pump can be seen in the accompanying sectional illustration. It consists basically of a first-stage, low-pressure gear pump, a second-stage piston pump and an unloader gear. The first-stage pump draws fluid from the reservoir and delivers it under pressure to the second-stage pump. The capacity of this second stage is less than that of the gear pump, and the surplus fluid is by-passed through a relief valve set to maintain the required low pressure. A limited quantity of fluid is also returned to the reservoir, so dissipating any heat generated.

High-pressure fluid delivered from the second-stage pump to the high-pressure outlet acts also upon the underside of an actuating piston which controls the unloader gear. In the "off-load" condition the low-pressure supply to the second stage is cut off by the unloading valve except for a small flow through a restricted passage. This flow maintains full pressure in the system during an idling period, any surplus being returned to the reservoir. While the second-stage pump is deprived of fluid a depression is created on the underside of a compensator piston, which moves so as to permit increased flow through the relief valve, so reducing the power input required. This, in conjunction with the starvation of the second stage, results in the whole pump running with the minimum expenditure of energy while in the idling condition.

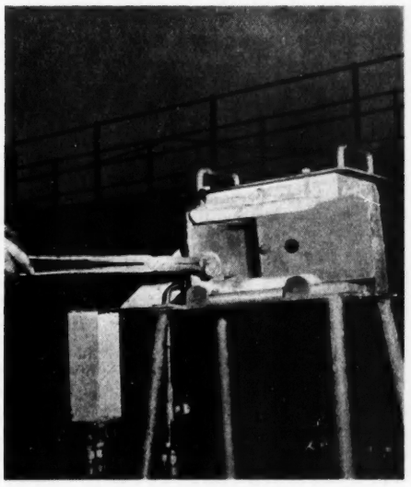


Industrial hydraulic pump for pressures from 1000 lb to 4000 lb per square inch and outputs from 2½ to 5 g.p.m.

Oxy-Acetylene Fired Rivet Furnaces

A COMPACT portable heating furnace for rivets, which has been developed by British Oxygen Gases, Ltd., can be used in close proximity to the working area, and eliminates the need for a "catcher" at stations normally inaccessible for the solid fuel furnace generally used for rivet heating in shipyards and on constructional sites. The new furnace uses oxy-acetylene and incorporates a specially adapted burner fitted to a "Weldogen" blowpipe shank. Gas supplies are supplied to the furnace through a manifold and controlled by means of a duplex valve.

The burner is designed to give just enough heat to suit the size of the furnace, which is normally used for heating rivets ⅜in diameter by 2½in long, although rivets up to 1in diameter and 4in long can be accommodated if necessary.



Rivet furnace heated by oxy-acetylene in use

Four or six jet burners are available for use with the furnaces, one of which can be seen in use in the accompanying illustration.

We are informed that one of the prototype furnaces in operation is capable of heating eighty rivets an hour with a consumption of 35 cubic feet of oxygen and a similar amount of acetylene per hour. Another heating fifty rivets an hour uses 13 cubic feet of each gas. As the furnaces do not produce fumes, they have been used successfully in confined spaces. They require little preliminary "heating up" time and, when out of use, fire danger from any hot solid fuel remaining in the hearth is eliminated.

Lloyd's Annual Report

LLOYD'S REGISTER OF SHIPPING has issued its report for 1956, which says that ships launched in 1956 exceeded the 1955 total by 1,250,000 tons gross. Of this amount Japan was responsible for 80 per cent, the remainder being shared by other shipbuilding countries with the exception of Great Britain and Sweden. A diagram shows the countries arranged in order of amount of tonnage launched, Japan occupying first place, and also indicates that, based on average time under construction, only Spain takes longer to build ships than Great Britain. The report comments on the increasing size of oil tankers and the constructional problems involved. Brief particulars are given of the major marine engine installations dealt with during the year and the report goes on to refer to the guidance notes issued on torsional vibration and to the possible causes of propeller shaft failures. A further note records that dichlorodifluoromethane has practically superseded carbon dioxide as a primary refrigerant. A section of the report deals with research and investigation services, including the Society's interest in other associations and its own department, which is concerned principally with the investigation of service failures. During the year, work on load line assignments increased as did also the number of tonnage calculations undertaken, and the number of ships completed to class is given as 661 of 3,266,813 tons gross. Plans were approved for ships totalling 6,468,000 tons gross, of which 4,352,000 tons were for ships to be built abroad. The report states that at the end of the year 729 ships of 4,610,000 tons gross were building under Lloyd's survey, representing 57 per cent of world construction. The land division section of the report deals with atomic energy contracts, work at the oil refineries at home and abroad, and inspection of hydro-electric schemes. The report concludes with a number of statistical tables including: ships classed with Lloyd's; flag distribution, age distribution, propulsion analysis, and fuel analysis of world tonnage; world tonnage of oil tankers and the age distribution of the fleets. In addition there are two diagrams, one showing the percentage of world tonnage launched in the various countries and the other showing the percentage tonnage launched for export in the same countries.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

DETERMINATION OF DROP POINT OF PETROLEUM GREASE

No. 2877 : 1957. Price 2s. 6d. This standard is technically identical with I.P. 132/57 and contains full details of the apparatus and the procedure to be adopted in the determination of the drop point, as well as specifying the temperature to be used and including the thermometer specification.

DIMENSIONS OF SCREWED SEALING PLUGS (LOW PRESSURE) WITH UNIFIED SCREW THREADS.

No. 2859 : 1957. Price 3s. The plugs specified in this publication, although intended primarily for use in internal combustion engines, are expected to be suitable for use in other types of engineering equipment. No attempt has been made to describe all the possible applications of the plugs; but in internal combustion engines and automobiles they are for draining, filling and level-indicating purposes in connection with lubricants, fuels and coolants. They will provide sealing under the heads against pressures up to 200 lb per square inch for water and up to 150 lb per square inch for steam (other than superheated steam), air, gas and oil. The plugs have been designed for use with British Standard open-ended spanners, tubular box spanners and wrench keys.

AMINOPLASTIC MOULDING MATERIALS

No. 1322 : 1956. Price 5s. This standard is concerned with three types of aminoplastic moulding materials. The type A (General) material covered includes cellulose-filled (former type UX) and wood-filled urea-formaldehyde (former type U) materials; the type M material, which has improved resistance to hot water, is normally a cellulose-filled melamine-formaldehyde material, and the type H material, which has improved electrical properties at high temperature, includes moulding materials (usually melamine-formaldehyde) with mineral fillers such as asbestos and glass fibre.

A simple statistical technique for control of quality which has been adopted is intended to assure the purchaser that no batch will fall below a certain minimum level of quality, and that the average quality of a number of batches will be appreciably higher than this minimum level. This procedure takes into account the casual variations inherent in methods of test, but ensures that the average quality of the material is not merely the bare minimum to meet the lower limit. Twelve properties specified together with tests in the publication include requirements for cross-breaking strength; impact strength; boiling water absorption; surface resistivity after immersion in water; volume resistivity; power factor; permittivity; tensile strength; cold water absorption; plastic yield; electric strength, and tracking. Methods of test are given for each of the specified properties, and reference is made to the B.S.I. Certification Mark scheme.

Industrial and Labour Notes

Industrial Arbitration

The British Employers' Confederation has circulated to its members a statement setting out its views about industrial arbitration. It says that the events of the recent provincial bus dispute support the contention of employers who say that the operation of compulsory arbitration under the Industrial Disputes Order is one-sided.

The Industrial Disputes Order was made in 1951 under a defence regulation, and thus continued, by emergency powers, a wartime arrangement. The Government has said that it wishes to get rid of such of these regulations as remain, and with that in mind, the British Employers' Confederation some time ago appointed a committee to review arbitration as a method of settling industrial disputes. As is remarked in the Confederation's statement, many industries have in the past voluntarily entered into procedure agreements for dealing with disputes, whether they arose on an industry-wide scale between an employers' organisation and the trade unions or between a single employer and his workpeople. In some cases, such agreements provide in the last resort for reference of the dispute to the arbitration of an independent person or tribunal. Apart from standing arrangements of this kind, resort to arbitration voluntarily is possible in any dispute, and the Industrial Court, set up by the Act of 1919, has been freely used. In contrast with the position under the Industrial Disputes Order, recourse to the court is by agreement between the parties ; its award does not purport to have any legal sanction behind it, but because the parties agree to go to the court, its moral authority is correspondingly enhanced.

The Confederation's statement goes on to say that there are several industries in which both the employers' organisations and the trade unions have never regarded industrial arbitration as a necessary or desirable part of the machinery for handling their disputes. They have preferred to deal internally with any dispute, and, the Confederation says, their success is illustrated by their relative freedom from strikes and lockouts. But, the statement continues, an aspect of the Industrial Disputes Order to which considerable importance is attached in some industries is the provision under its " issues " procedure by which voluntary agreements in an industry can in effect be enforced on all employers in that industry without subjecting it to the necessity of a statutory wages council. In present circumstances and in many industries, however, problems are more often caused for the employers' organisations by non-federated employers paying rates of wages above those agreed rather than by their paying less than the agreed rates. The availability of the " issues " procedure is, nevertheless, a warning to employers to observe agreements.

With these various considerations in mind, the Confederation's committee reached the conclusion that the machinery of the Industrial Disputes Order should continue to be available, but should be applied only in those industries in which both the employers' organisation and the trade unions wish it. Effect could be given to this, it is suggested, by a simple enabling act under which the Minister of Labour could make, first, an order which would contain the main provisions of the Industrial Disputes Order and, secondly, a series of subsidiary orders which would apply the provisions of the principal order to a trade or industry in which the employers' organisation and the trade unions wished this to be done. The procedure envisaged, the Confederation says, would not be available in industries where terms and conditions of employment are not settled voluntarily, but it would provide support to voluntary machinery at the stage in its development in which, because of weakness on the part either of the employers' organisation or of the trade unions, agreements reached through the machinery would be difficult to enforce. It would thus have the merit of providing a halfway house between a statutory wages council and completely voluntary machinery. It would, moreover, pay regard to the voluntary principle in industrial relations to which not only trade unions and employers' organisations but also governments, regardless of political complexion, attach so much importance.

The Coal Board's Surplus

The National Coal Board's statistical statement for the quarter ended March 31 last shows that a surplus of £8,800,000 was earned. The saleable tonnage from the Board's mines during the quarter was 56,360,171 tons, the amount " disposable commercially " being 52,844,570 tons. The total costs were £214,221,329, and the proceeds were £225,812,666, leaving a profit before charging interest of £11,591,337. The estimated profit on opencast working was £2,055,000 and the profit on the Board's ancillary undertakings has been assessed at £1,851,000, thus making the total profit for the quarter £15,497,337. Provision for taxation and other charges required £518,000 and the interest payable to the Minister of Power amounted to £6,180,000.

The estimated loss on imported coal in the first quarter of this year was £4,215,000, an amount which was recovered in the general price for coal paid by consumers. In issuing its statistical statement, the Board has pointed out that the first quarter of the year usually shows the best results. The Board has stated also that it will incur substantially greater expenditure during the remainder of this year, and that the latest increase in coal prices is expected to give a " relatively small surplus in 1957." The Board's accumulated deficit was £23,800,000 at the end of last year.

Organisation and Methods Training Council

A small number of industrial companies which have exchanged experience about organisation and methods training have agreed to form and finance an organisation to pool that experience and promote training. It will be known as the Organisation and Methods Training Council, and the firms participating are Dunlop Rubber Company, Ltd., Imperial Chemical Industries, Ltd., Rolls-Royce, Ltd., Shell-Mex and B.P., Ltd., Stewarts and Lloyds, Ltd., The Metal Box Company, Ltd., Unilever, Ltd., and The United Steel Companies, Ltd. Sir Thomas Hutton has been appointed chairman of the Council, the office of which is at 307, Cecil Chambers, 86, Strand, London, W.C.2.

The objects of the Organisation and Methods Training Council have been stated as follows : to conduct an investigation into the basic training required for those in industry and commerce who carry out analytical studies to increase effectiveness in organisation and administration ; to run pilot training courses for such people ; to help selected teaching institutions to start regular training courses, and to carry out such other measures as may be desirable to promote the development and use of the techniques required for these studies. The new Council says that it intends to co-operate fully with all other organisations which are interested in organisation and methods training.

Work in Compressed Air

The Minister of Labour has published statutory draft regulations concerning special measures for protecting the health and safety of men employed on work in compressed air. The publication of this draft provides an opportunity for organisations and individuals to consider the requirements and to make representations on them to the Ministry. Such representations should be submitted to the Ministry of Labour, 8, St. James's Square, London, S.W.1, to be received not later than August 29. In particular, the new regulations have been designed to ensure correct control and supervision over procedures, both in compression and decompression.

Pressure for Higher Wages

At the recent annual meeting of Edgar Allen and Co., Ltd., the chairman, Mr. W. H. Higginbotham, made some comments about " organised pressure for higher wages." For many years past, he said, that pressure—without commensurate increase in output or in services—had been directed successfully first at the vulnerable nationalised industries and thereafter at the so-called private sector of industry which, however reluctantly, had had to submit. The pattern was only too familiar, Mr. Higginbotham continued, as likewise were the reasons advanced in support—higher cost of living, profiteering, extravagant dividend distributions, monopoly activities and restrictive practices.

In the present difficult position, Mr. Higginbotham went on to say, little help could be expected from the trade unions, whose leaders seemed in general to be more concerned in securing higher wages and shorter working hours, regardless of consequences to the community or even to their own members. Likewise, he added, little could be expected from politicians, to whom votes and popularity were so essential ! But, Mr. Higginbotham observed, history provided many examples that where constituted authority failed, the people themselves might succeed, and it was to ourselves that we must look for our future prosperity.

Government Stocks of Zinc

Last December, the Board of Trade announced that it was about to make arrangements for reducing its stocks of zinc. It has been decided to sell about 27,000 tons of zinc in a period of not less than nine months, beginning in September. The first sales will be of about 9000 tons for delivery and pricing over the three months September to November. The disposal of the remaining 18,000 tons in two or more subsequent three-monthly periods will be the subject of further announcements from time to time. The Board of Trade says that, of the 27,000 tons, about 9500 tons will be offered for sale by open competitive tender. The tender for the three months September to November will be for 3200 tons. The remaining 17,500 tons of zinc will be offered to the original suppliers or their agents.

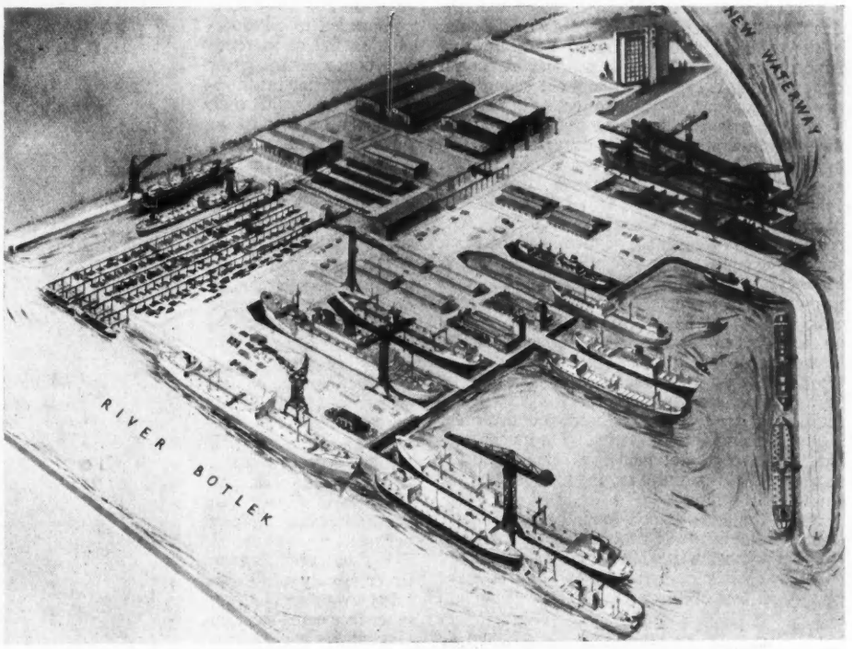
Opening of New Shipyard in Holland

AT the end of June, the Royal Commissioner for South Holland, Mr. J. Klaasesz, performed the opening ceremony of a new shipyard at the eastern end of the Isle of Rosenburg, and Mrs. Meftah, the wife of the Iranian Ambassador in Holland, laid the keel of a 33,000-ton oil tanker, one of two such ships which have been ordered for the Iranian Merchant Navy. The new yard, Verolme Dock and Shipbuilding Company, Ltd., is under the control of Verolme United Shipyards, an organisation of which Mr. C. Verolme is the managing director, and which is a combination of four companies, including Jan Smit C.Z. N.V. at Alblasserdam ; De Haan and Oerlemans Scheepswerf N.V. at Heusden ; Nederland Engineering Company, Ltd., at Ijsselmonde, and the new yard at Botlek.

The idea of building a new shipyard largely stemmed from the rapidly expanding oil tanker building programme and the yard is planned so as to be able to build the largest tankers currently planned. The site chosen for the new venture was an area of barren land on the south bank of the New Waterway to the port of Rotterdam, roughly triangular in shape and bounded on the south by the River Botlek. The area involved is approximately 80 hectares and the level of the land has had to be raised to suit the purpose for which it is intended. Full development of the site is planned in stages of which the first includes the building of a berth and ancillary shops to enable ship construction to go forward while the succeeding stages towards the completion of the overall plan continue to progress.

Berth number one is piled and has a reinforced concrete deck in which are inset steel plates to mark the heads of the piles and so help in distributing the building loads. Ships of up to 50,000 tons deadweight can be constructed on this slip, which measures 224m by 35m, and it is served at present by two travelling tower cranes, running on piled tracks, each rated to lift 40 tons at 21m radius or 16 tons at 45m radius. Stores are arranged under the berth where it rises above ground level and on the river wall there is a single plate gate which will be removed by crane when a ship is ready for launching.

Provision has been made for steel supplies to be brought by water and for that purpose a quay about 300m long and fronting the River Botlek is being constructed. Leading from the quay, and at right angles to it, is a road with storage racks on either side extending for a distance of 280m. Serving the area is an overhead crane running on rails and having a span of 30m, two 5-ton hooks for lifting sections and two lifting magnets for handling plates. Batteries energise the magnets should there be an electric power failure. The rails are carried out over the river to enable the steel to be unloaded direct from ship to storage. Sectional material moves direct into the shops but the plates are placed on electrically-driven rollers which convey them to a shed housing the flattening rolls. After this operation the plate is moved on to a section of roller conveyor which can be traversed so that a steady flow of plates can be moved to the two optical marking-off tables housed in a building framed in steel and covered with asbestos sheeting. These tables can handle plates measuring 13m by 3m and air-operated arms cause the conveyor rollers to be lowered, so that the plate is placed on the table for marking-off, and then raised to enable the plate to continue, in the direction of flow, into the plate shop by means of power-driven rollers which extend across the full width of the shop. This shop consists of two bays about 130m in length and a third somewhat shorter, each bay being 30m wide. In the first bay are a number of presses, served by 10-ton half-portal cranes, and 10-ton overhead cranes, while the second bay is subdivided into smaller bays to handle light plates and angles and each is served by 3-ton cranes. Furnaces are fitted in the third bay, where the stores are also found. Across the eastern end of the two main plate shed bays is a prefabrication shop, 90m long by 30m wide by about 20m high, and equipped with two 40-ton overhead cranes, each having two 20-ton hooks. Our first illustration shows part of the shipyard under construction with the plate and prefabrication shops in the background.



The layout, as planned, of the new yard of the Verolme Dock and Shipbuilding Co., Ltd.

Verolme shipyard showing building dock under construction in the foreground, and plate and prefabrication shops in the background

Another building, measuring 60m by 22m, was the first to be erected on the site and was equipped as a complete shop so that all the operations necessary to help towards the early functioning of the yard could be carried out. When the main shops are fully operational it is planned to convert this shop into an apprentices school. Other buildings projected are a combined carpenter's and joiner's shop, a welding shop and a block having washplaces on the ground floor with a canteen on the first floor. The latter, seen to the right of our illustration, is practically complete and part of the building is at present being used for temporary offices but a new multi-storey office block, capable of housing all the staff, is to be built at the northern boundary of the site, near the new waterway.

In the overall plan for the shipyard there is both space and provision for expansion of building capacity and alongside the present berth work is proceeding in excavating a building dock which will measure when complete 265m by 43m. This dock in which ships of 80,000 tons deadweight may be built, is of the displacement pattern and its construction will involve the pouring of 80,000 cubic metres of concrete. Looking further ahead, plans have been prepared for the construction of a third berth which will be similar in design to the one now under construction and able

to accommodate ships of over 100,000 tons. The building berth and the two building docks can be seen in the impression of the completed shipyard. To the left can be seen a wet basin, opening off the River Botlek, in which a floating dock of about 8000 tons capacity is to be placed, while the riverside quay is shown extended by some 300m to form a pier, equipped with travelling cranes, to moor ships under repair. The pier, when finished, will form one leg of an extensive E-shaped wet basin in which the top leg is extended to follow the line of the New Waterway. In each half of the basin the plan provides for two dry docks which will range in size from one capable of taking a 20,000-ton ship to one able to accommodate ships of the largest size. The basin is planned to enable the yard to undertake a large volume of repair work and also to provide adequate facilities for fitting out new construction.

Orebro Water Tower

WATER towers are characterised by a certain architectural intransigence. They must frequently be built in conspicuous places, on high ground, so that sufficient "head" is available, and the local residents generally object when such a bulky structure is proposed in their midst. The novel design of the tower recently erected at Orebro in central Sweden is therefore of particular interest, not only because of its striking appearance, but also because that appearance is based on a rational structural design, which is claimed to be more economical than the usual run of water towers.

The appearance of the tower may be seen from the first illustration. Its capacity is 2,000,000 imperial gallons, and its top water level is 160ft above the ground. The largest diameter is 146ft, the diameter at the foot is 33ft, and the depth of water in the storage tank is 44ft. The design was evolved in the following way. First, three polygonal tanks were proposed, interlocked like the cells in a beehive, and each with its own ring of columns. As a simplification, one tank was substituted, with a central tower and an outer ring of columns. On analysis, however, it was found that the outer columns would be too slender, and a continuous cylinder would be needed as an outer support. So the diameter of the central tower was increased and the outer supporting ring dispensed with. The mushroom-like shape thus obtained was elaborated by enlarging the base and merging the foot and the top monolithically.

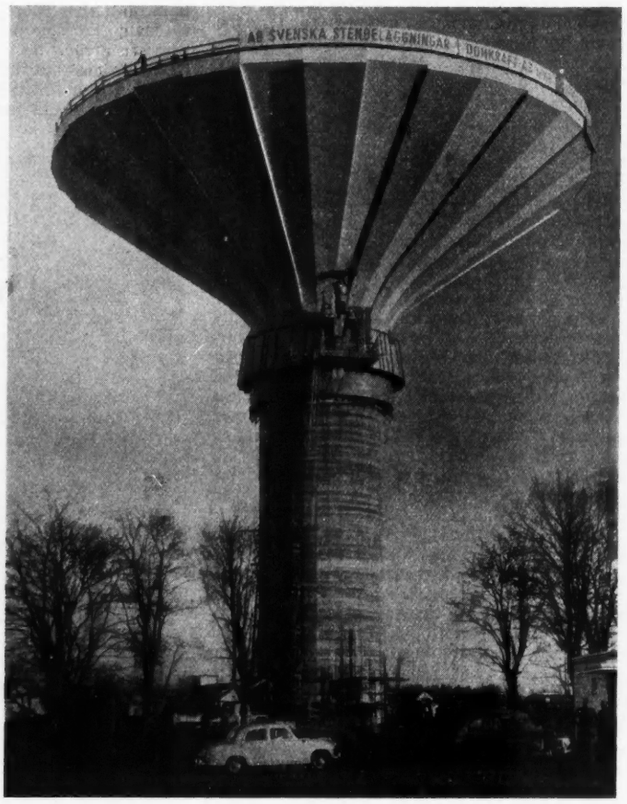
Inside the cone-shaped roof above the water tank a restaurant will probably be housed and two lifts will be installed in the central reinforced concrete column. A mast 100ft high will be placed on top of the tower for television and radio transmission.

The slender shape of the tower avoids undue dominance over the surrounding housing area. But at the same time the conical shape of the reservoir and the circular column led to considerable saving of material and, consequently, lower cost. In basing the foundations on solid rock it was necessary to go down to a depth of about 30ft. Three basements below ground level will be used as storerooms and a boiler-room for the restaurant.

The outer wall of the reservoir is constructed of reinforced concrete and is prestressed in accordance with the Freyssinet system, using 208 horizontal cables, each one consisting of twelve wires of ¼in diameter and covering a half turn. The wall thickness varies between 12in and 18in. The tensile strength of the wires was 15,500kg per square centimetre. The outer surface of the tower is polygonal with thirty-two faces, every other face being recessed 8in; these 8in surfaces are utilised as end anchorages for the cables. As would be expected in a prestressed design, the principal compressive stress in the concrete will remain at maximum load when the reservoir is filled with water.

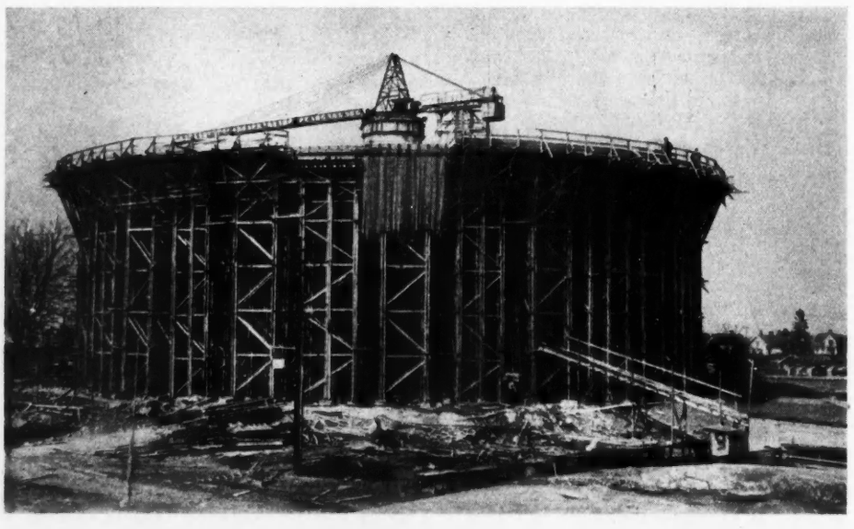
The point which has perhaps attracted the greatest interest about the tower is that the reservoir section was constructed on the ground (as illustrated) and then hoisted to its final position with hydraulic jacks, thus eliminating a tall scaffolding and the attendant risks of cracks caused by deformations in the scaffolding when the concrete was cast. In addition, prestressing of the cables, testing for watertightness and painting of the outer wall of the reservoir could be carried out at the low level. It is thought that this is the first time that this method has been used for such large loads.

Prior to the commencement of work on the reservoir proper the inner lift cylinder was cast,



Construction of the tower well advanced. Lifting has been completed to the full height in this view

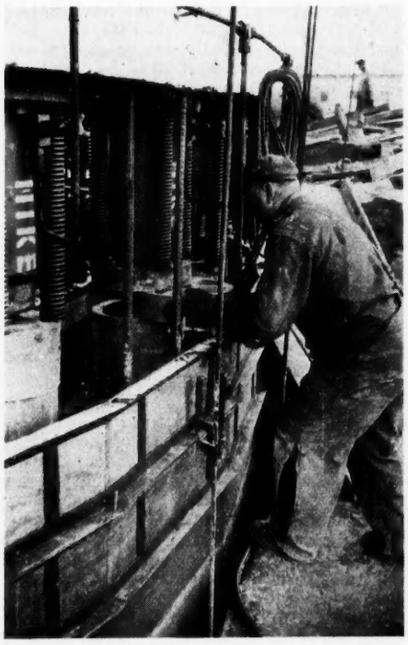
Architect's impression of the completed water tower at Orebro in Central Sweden



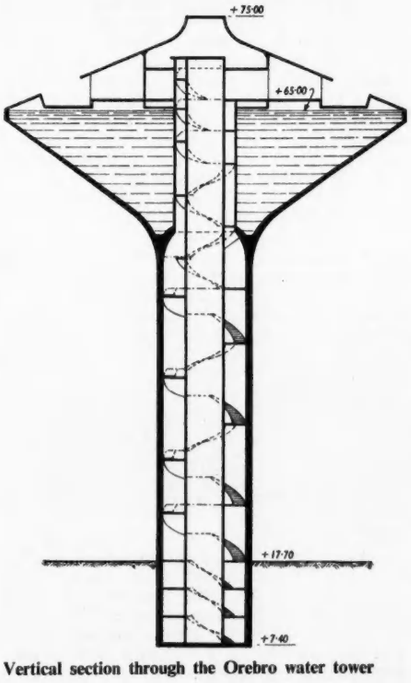
The conical structure of the actual storage tank of the reservoir was built at ground level, in the manner shown here. Note the inner lifting cylinder with the crane mounted on it

using sliding shuttering. This cylinder served as support for a crane. The reservoir proper weighed 3200 tons and to lift it thirty-two hydraulic jacks, each of 100 tons capacity, were used. The lifting speed was about 2ft per day ; after lifting 1ft the jacks were supported by concrete cylinders, which were subsequently cast into a substantial ring of reinforced concrete. The lifting operation was directed from a control board inside the reservoir, with instruments to check verticality and alignment, and was completed satisfactorily. If, in the future, the water pressure in the town needs to be increased, the reservoir can be raised still further.

The cost of the tower structure is stated to have been about £165,000. A tower of conventional design would have involved a higher cost, probably about £15,000 to £20,000 more, it is considered. The consulting engineers were Vattenbyggnadsbyrån (VBB), and contractor AB Svenska Stenbeläggningar, Uppsala.



Hydraulic jacks for lifting the reservoir. Note the concrete cylinder being placed in position, and the shuttering for the *in situ* concreting



Vertical section through the Orebro water tower

Amphibious Vehicles for Bulk Transport

The article describes an amphibious system of bulk transport, applicable in the first instance to industries such as the German iron and steel industry, where raw materials have to be sent by water for part of the way, and by rail for the remainder. The idea is based upon the " transport tube " introduced by the Reichswerke für Berg- und Hüttenwesen during the war. Two kinds of vehicles have been designed as well as an inclined hoist for transferring the containers into and out of the water and setting them on to railway bogies.

"THE most economical way of doing an operation is to avoid the need for it." It is only comparatively recently that this principle has been applied to the rationalisation of transport; it has long been neglected. Although different methods of transport and materials handling have been improved to a high degree, there frequently remains a lack of harmony between successive operations and a degree of complexity which dissipates a great deal of time and effort. An example is the transport of coal, coke and ore to German steel works. Of the twenty-three principal iron and steel works in the Federal Republic only two unload bulk materials brought by waterway directly from the barge into the blast-furnace bunkers or mixing beds. All others require intermediate rail transport over longer or shorter distances involving the expense of transhipment. The transhipment of ore, for instance, costs on the average between DM.1 and DM.1·80 per ton, depending on the lump size, so that a steel plant requiring, say, 2,000,000 tons of ore per year is expending substantial sums under this head alone. Another factor is the deterioration caused to certain classes of materials by the handling. If coke, for instance, is unloaded by grabs it may suffer a loss in value of up to 5 per cent.

Considerations such as these led to the design of a vehicle which could be used both on water and on the railway. The underlying principle is the self-trimming transport tube, which was invented by E. Westphal some fifteen years ago.

In this system large cargoes are distributed over a number of small and easily handled vessels—of about 100 tons each—which are assembled to form rafts. These are propelled by two tug units, one at each end. On arrival at their destination the rafts are again dismantled for unloading.

It was the intention to save handling costs by lifting each unit out of the water by crane and tipping it where required by rotating it in its supporting cradle. This aspect has not, however, been developed so far. The new amphibious technique is due to work by the study group Arbeitskreis Amphibischer Verkehr, which was formed by Hoesch-Werke A.G., Dortmund, and the A.G. für Berg- und Hüttenbetriebe, Salzgitter-Drütte, successor to the Reichswerke,* which originally built and operated the Westphal raft. The first results of the collaboration between the two concerns were shown at this year's German Industries Fair at Hanover, when two full-size amphibious containers were exhibited, as well as the working model of a complete installation.

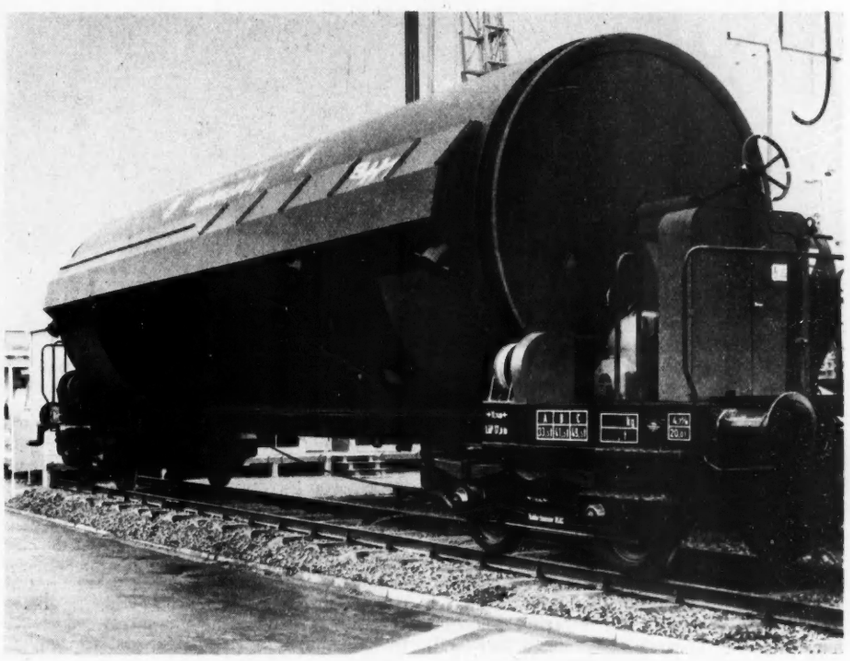


Fig. 1—Tubular amphibious container on bogies, three-quarters inverted for emptying. The vehicle can carry 50 tons and has a gross weight of 80 tons

The container built by Famas-Linke-Hofmann-Busch, G.m.b.H., Salzgitter-Watenstedt (Fig. 1) is designed on the lines of the conventional form of the Westphal transport tube. It was constructed as an automatically-trimming tubular vessel, 3in in diameter, with a top discharge opening 1·8m in width. For rail transport the length could not be in excess of 12m, i.e. half the length of the original Westphal container. It differs from the latter, in that the end bulkheads are constructed as bearing rings. Each ring

* See e.g. Dr.-Ing. E. Westphal's paper in *Stahl und Eisen*, Vol. 70, 1950, No. 3, pages 97–109 ; also *Civil Engineering and Public Works Review*, Vol. 45, 1950, pages 454–5.

rests on two rollers, which can be driven by two 13·5 h.p. motors at ½ r.p.m. for inverting and discharging the container. Most of the contents fall clear of the track, but some are discharged on the rails, so that it is necessary to discharge over a grid. In order to clear the bogies the end bulkheads are arranged at an angle. The capacity is 65 cubic metres and the container with bogies has a tare weight of 30 tons. With a permissible axle loading of 20 tons the maximum total weight is 80 tons, giving a load capacity of 50 tons. When afloat the maximum draught is 1·8m.

The transport tube is fitted with an intermediate bottom which permits unloading by means of a grab as well. Thus the tube can be unloaded where there is no landing installation. For rail travel, there is a bolting device in the middle of the tube which secures it against displacement ; the drive need not be released for emptying the tube. Frontal tractive and impact forces with a maximum pressure on the buffers of up to 200 tons can be withstood.

The capacity of the driving motors is sufficient to unload the tube under all conditions, even in the case of very unfavourable loading with material of high specific gravity, such as ore. The tube possesses adequate stability even when it is floating empty.

The second design of amphibious container is by Orenstein-Koppel und Lübecker Maschinenbau A.G., Dortmund. It has been the aim of the designer to produce a container with lateral discharge which is thereby adapted to the majority of existing bunkers and which is gravity operated and does not require any external source of power. The problem was solved by dividing the container longitudinally into two similar halves. These are rigidly connected by couplings, thus forming a single unit with good floating stability. For rail travel, the container is placed, with its supporting surfaces at each end, on the two-axle bogies and fastened down by four screw spindles. The assembly fulfils the same requirements as the first one, with regard to the transmission of tractive and impulsive forces.

For unloading at the bunker, the four spindles are unscrewed and the couplings undone. The container is held in an arresting device ; when this is unlocked by a hand lever, the two halves roll over on their bearing surfaces, which are provided with teeth to safeguard against slipping. The container halves tilt under gravity through 150 deg. from the vertical, and are automatically locked in the end position. The centre of gravity is arranged in such a way that when the empty halves are released they right themselves. They are then coupled together again and rigidly connected with their supports on the bogies.

The technical data of the two designs are summarised in Table I :

TABLE I—*Hoesch-Salzgitter Amphibious Vehicles*

	A	B
Design	Tubular container	Twin U containers
Method of discharge	Lateral and central	Lateral
Mode of operation	Electric	Gravity
Weight of container, tons	15·0	15·0
Weight of bogies, tons	30·0	28·7
Carrying capacity, tons	50·0	51·3
Carrying volume, cubic metres	65	75
Gross weight, tons	80·0	80·0
Number of axles	4	4
Axle load, tons	20·0	20·0
Length of container, metres	12·00	12·00
Length over buffers, metres	16·965	16·70

A—Design by Famas-Linke-Hofmann-Busch G.m.b.H.
B—Design by Orenstein-Koppel und Lübecker Maschinenbau A.G.

Fig. 2—Twin-U container, capacity 75 cubic metres (50 tons) ; gross weight 80 tons

For the transfer of the containers from the water on to the bogies, and conversely, a landing installation is required. Designed by Maschinenfabrik Deutschland A.G., Dortmund, it consists of a sloping traverser, one end of which is submerged in the canal, the other lies across a railway track. The traverser is winch operated and its carriage is designed to take either type of container. Hydraulic lifting gear is used to lower the containers on the bogies. It is claimed that the load handling capacity of such an installation is about three times that which can be achieved by conventional methods, such as grabs or cranes. One 50-ton load can be transferred every eight to ten minutes, giving an annual capacity of 1,500,000 to 2,000,000 tons.

Diesel Engine Production

It is announced that Fried. Krupp, Essen, has, after an interval of twelve years, resumed the construction of large ships' diesel engines. Initially uniflow-scavenge two-stroke crosshead engines, with cylinder diameters of 50cm, 62cm and 72cm are being built under licence from Burmeister and Wain, Copenhagen. Made in versions of up to twelve cylinders, they cover a range of 2900 h.p. to 15,000 h.p. A fourth series with cylinders of 84cm bore is in preparation ; this will extend the output range to over 20,000 h.p.

A " model 674-VTBF-160 " engine is at present on the test bed. It is a six-cylinder engine of 74cm bore and 160cm stroke, developing 7500 h.p. at 115 r.p.m. and a mean indicated pressure of 7·9 kg per square centimetre. Scavenging and supercharging air is obtained with two Brown-Boveri exhaust-turbo-blowers. The engine is of partly welded construction, with integral crankshaft, and has a specific weight of 42 kg/h.p., a length of about 13m and a height of 10m.

Annual Report of Demag Aktiengesellschaft

The ordinary general meeting of Demag Aktiengesellschaft was held at Duisburg on June 24. In their report, covering the year 1956, the board of management refers to the fact that West German industrial output had continued to increase, though at a reduced rate. This is ascribed to restrictive measures adopted to damp down the boom, which took effect in the investment field, particularly the building industry, about the middle of last year. As concerns the company's exports, the value of orders reached a peak of DM.400 million, representing 60·2 per cent of the total incoming orders, while orders for the home market, which in 1953 still represented 72·8 per cent, have steadily decreased since then to 39·8 per cent during 1956. Export orders last year included an important contract, worth over DM.100 million, for a wide strip rolling mill for Hindustan Steel Private, Ltd., Calcutta. Demag, in association with Fried. Krupp, has been engaged since 1953 on the construction of the 1,000,000-ton integrated steel works at Rourkela (Orissa), which belongs to the same company. Extensive consulting activities are reported by the division for integrated plants and mineral exploration and the steelworks division ; these ranged from cases where whole works were being built and equipped by Demag to instances where none of the firm's production was involved. Investments at home centred largely on the works at Duisburg and Wetter (Ruhr), dealing respectively with heavy engineering and batch production. Since 1948 capacity had been expanded in certain fields only, the remaining investment aiming at restoring pre-war capacity and at modernisation. The value of machinery installed at Duisburg during 1955 and 1956 was four times that of all the other works. For replacements the company had had to draw on taxed profits as well as borrowed capital and funds resulting from depreciation. The wide gap between the rates of depreciation allowed by the tax authorities, and the actual replacement costs, is stated to remain a severe handicap in meeting foreign competition. Following an increase of DM.23,600,000 in the nominal capital, a further increase of DM.18,000,000 is envisaged for this year, bringing the nominal share capital up to DM.84,000,000. Production costs rose by 7 to 8 per cent, compared with 5 per cent in 1955. There was full employment in all plants, and design offices were capable of coping with their work in many instances only by working overtime.

The company states that it welcomed the institution of a common market as a step towards building up a United Europe. While the common market would tend to stabilise the trade position within the six countries, it was not considered likely that a sudden expansion of trade would result. During the past five years 10 per cent of the Demag total turnover had gone to the other five ECSC countries. Among staff and welfare matters may be noted the 10 per cent increase in the labour force during the year under review. Basic wages in the metal-working industries of North-Rhine-Westphalia rose from DM.1·10 before August 1, 1950, to DM.1·84 after October 1, 1956, an increase of 67·3 per cent over 1950. By comparison, the Demag basic wage rate increased by 78 per cent, or 86·5 per cent if the dividend-linked bonus is included. During the same period the cost of living for recipients of incomes of DM.360 per month is stated to have increased by 14 per cent over 1950.

Electrification, Strasbourg-Mulhouse

Electrification of the French Railways' main line between Lille and Bâle has been carried a stage further with the putting into service on June 2 of the section Strasbourg and Mulhouse. French railway trains are now being electrically hauled all the way between Valenciennes and Mulhouse, a distance of 355 miles. The electrification of the remaining 21 miles of line between Mulhouse and Bâle is to be completed by the end of July.

Philo Steam Power Station

BY OUR AMERICAN EDITOR

No. II—(*Continued from page* 177, *August* 2)

The 120MW super-pressure unit which went into commercial operation at the Philo power station of the Ohio Power Company in June is to-day the most advanced steam-electric generating plant operating in the United States. While initially operating at less than rated design conditions, the unit is expected ultimately to achieve a net heat rate of 8530 *B.Th.U. per kilowatt-hour. The boiler has been designed to deliver steam at a pressure of* 4500 *lb per square inch gauge, at a temperature of* 1150 *deg. Fah. and at a rate of* 675,000 *lb per hour. The tandem compound turbine has two stages of reheat, respectively raising the steam temperature from* 800 *deg. to* 1050 *deg. Fah. at* 1225 *lb per square inch gauge and from* 630 *deg. to* 1000 *deg. Fah. at* 185 *lb per square inch gauge.*

COAL is being handled by the present facilities at the power station. A new bunker of 1100-ton capacity has been erected and provides approximately a twenty-four-hour storage. Since the measurement of performance is vital on this unit, coal to the unit is weighed three times : (1) on the main belt scale, (2) on the unit's own belt scale, and (3) on a strain-gauge scale in series with the second scale.

A direct-fired system is used. Coal from the bunker is crushed *en route* to the cyclones. One hammer mill crusher of 50 tons per hour capacity serves each cyclone. An apron feeder with variable speed control conveys coal from the bunker to the crusher and controls coal flow to the cyclone. Primary air from the forced draught fan at a temperature of 685 deg. Fah. joins the coal stream from the feeder and carries it through the crusher and into the cyclone. Tempering air is available to maintain the coal-air mixture at a safe temperature. A small flow of cool air is introduced at the inlet end of the feeder to maintain a dry atmosphere within its sealed casing. The following table gives an average analysis of the coal being burned in the Philo unit :—

Coal Analysis, Philo Power Station

Moisture, per cent	10
Ash, per cent	16
Volatile, per cent	35
Fixed carbon, per cent	39
Heating value, B.Th.U. per pound	10,500
Sulphur, per cent	4
Ash fusion temperatures (reducing atmosphere) :	
Initial deformation, deg. Fah.	2,130
Fusion, deg. Fah.	2,290
Fluid, deg. Fah.	2,425

The primary burner, which is centrally situated at the inlet end of the cyclone furnace, imparts a whirling motion to the crushed coal and primary air mixture, which distributes the coal over the slag-covered surface of the cylindrical furnace. The velocity of the coal and air stream entering the burner is regulated by a cantilever damper to maintain a high tangential velocity. To complete the combustion, secondary air, constituting 75 to 80 per cent of the total air, is introduced tangentially to the cyclone furnace in the same direction of rotation as the primary air and coal. The high velocity produces a helical path toward the rear of the cyclone where the gas reverses direction before entering the discharge throat. Because of its viscosity the movement of the molten slag on the surface of the furnace is much less than the velocity of the entering air, and there is an intense scrubbing action of the high-velocity air on the coal particles imbedded in the slag. This condition favours very high combustion rates. The quantity and distribution of secondary air are regulated by cantilever dampers which also maintain a smooth entrance of high-velocity air. Tertiary air, constituting 3 to 8 per cent of the total air, is admitted at the central region of the primary burner to prevent excessive recirculation of fine coal in the primary burner and to supply the necessary air for combustion of fine material that gets into the burner vortex. The tertiary air is introduced tangentially to a cylindrical housing which gives the air the same direction of rotation as in the primary burner and is regulated by a cantilever damper. An automatic retractable oil lighting torch is installed in each cyclone for establishing coal ignition.

Molten slag tapped from the cyclones passes to the floor of the primary furnace and then to a water-filled slag tank. From this tank slag is pumped to the existing ashpit in the rear of the plant. The cyclone furnace is a very effective dust collector and for this reason no special dust-removal equipment has been provided. The steam generator is equipped with forty-five slag blowers. Twenty-four of these are fully retractable and are situated in the convection pass, while the others clean the walls of the secondary furnace. To limit condensate make-up, air is used as the blowing medium, and a blowing procedure has been designed to produce a minimum upset in steam temperatures. Two centrifugal double-width, double-inlet, forced draught fans with airfoil blading supply combustion air to the cyclones at 51in H_2O pressure.

The Turbo-Generator

The turbo-generator was designed and built by the General Electric Company, of Schenectady, New York. The 3600 r.p.m. tandem-compound, double-flow turbine is rated 125MW at initial steam flow of 675,000 lb per hour at 1150 deg. Fah. and 4500 lb per square inch. At full load, steam is expanded from these initial conditions to 1225 lb per square inch and 800 deg. Fah. in a double-shell, high-pressure turbine. The steam is then reheated in the boiler to 1050 deg. Fah. and expanded through the first reheat turbine to an exhaust condition of 185 lb per square inch and 630 deg. Fah. The steam is again reheated to 1000 deg. Fah., and then passed through the second reheat turbine and the double-flow, low-pressure turbine. The double-flow turbine is equipped with 26in long buckets in the last stage.

All four of these turbine sections are arranged in tandem on the same shaft, as shown in Fig. 4. The high-pressure turbine is carried between the Nos. 1 and 2 bearings with steam entering adjacent to the No. 2 bearing and flowing toward the front end of the machine. The first and second reheat turbine sections are arranged between the Nos. 3 and 4 bearings with the first reheat steam entering the middle section and flowing forward toward the front end before exhausting to the second reheater. Second reheat steam enters the same middle belt and flows through the second reheat section and then through a crossover to the double-flow low-pressure section. The double-flow section is carried between bearings Nos. 5 and 6.

The turbine, from the first reheat point on, is a conventional arrangement similar to many machines which General Electric has built. The high-pressure, high-temperature turbine, however, represents many new concepts. Designing for the high pressure was not as difficult as for the high temperature. The pressure parts tended to be relatively small because of the low specific volume of the steam being handled and, as far as possible, optimum pressure shapes of spherical and cylindrical design were used. The outer shell of the high-pressure turbine, for instance, is a perfect sphere except for the supporting horns, shell joints, steam inlets, and exhaust pipes.

The initial concept of handling the high temperatures was to use massive stainless steel inner shell sections in the high-pressure turbine. Because of the difficulty of providing adequate bolting materials, these shells might have been in a barrel arrangement with assembly of the rotor and the diaphragms from one end. This concept was unattractive for several reasons : (1) the high cost ; (2) the difficulty of getting sound stainless steel forgings or castings ; (3) the difficulties which were, at that time, being experienced with the lack of dimensional stability of stainless steel inner shells, and (4) the additional effort associated with maintaining a machine with a barrel type inner shell. For these reasons, among others, the General Electric Company suggested that steam cooling of the inlet steam pipes, first-stage nozzle assemblies, inner shell

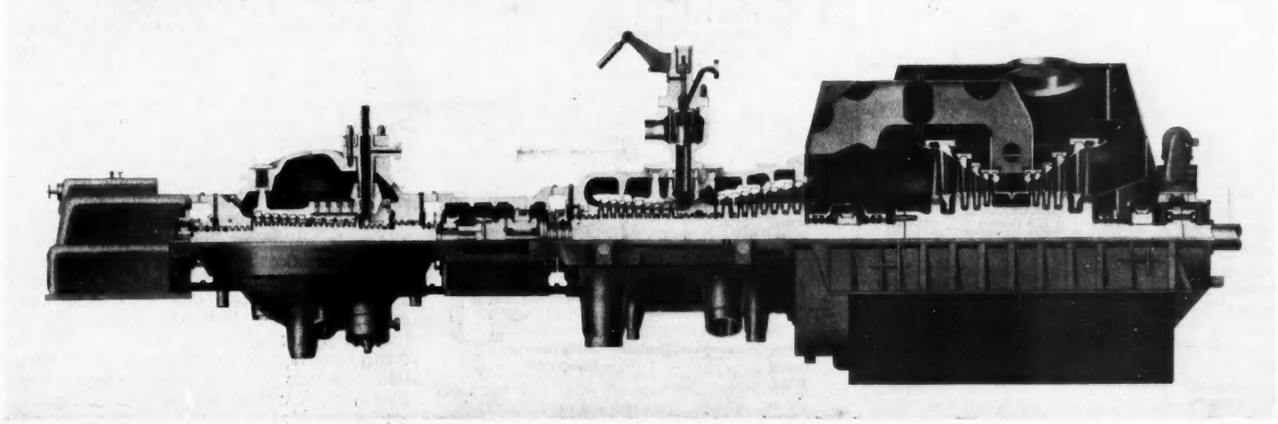


Fig. 4—Part sectional elevation of 125MW General Electric tandem-compound, double-flow turbine

and high-pressure packing be utilised. Also, it was suggested that the rotor be cooled on the first few stages, if necessary. With this cooling, the requirements for stainless steel could be limited to the inlet pipes, first stage nozzle assembly, the first three diaphragms, shell bolts, buckets and minor trim. The remainder of the machine, the inner shell, and the turbine rotor, could then be made of a ferritic material operating at reasonable temperatures. This cooling steam arrangement presented not only a highly satisfactory solution for the design of this machine, but also pointed the way toward future designs for even higher temperatures.

It was generally felt that experience should be obtained not only on the cooling steam arrangement of the shells and diaphragms, but also in the use of both ferritic and austenitic rotors. The ferritic rotor would operate with cooling steam passing over the first several wheels, while the austenitic rotor could operate without cooling steam on the wheels. Tests were run as to the better manner in which to obtain an austenitic rotor, either by the use of a solid austenitic forging from front standard to coupling or by the fabrication of a welded rotor with an austenitic centre section and ferritic ends. The latter is still under development so that two completely interchangeable rotors have been manufactured, i.e. one, entirely ferritic, and the other entirely austenitic. Two conditions of cooling have been planned, i.e. one, with the austenitic rotor and shell cooling alone ; the other, with ferritic rotor and both shell and rotor cooling. To accomplish this steam cooling by an exterior source of steam presented a real problem, because in one case the cooling steam flow required is about 40,000 lb per hour, and, in the other case, about 100,000 lb per hour. In both cases there is a small reduction in the overall cycle efficiency since the basic 4500 lb per square inch, 1150 deg. Fah. cycle is being diluted by a 3800 lb per square inch, 980 deg. Fah. cycle (the first stage pressure at which steam enters the machine). At first it was suggested that the cooling steam be taken from an intermediate header in the steam generator. This proved impossible because of the requirement of meeting the two differing flow rates, the higher of which would tend to starve the secondary superheater. In the arrangement finally adopted, steam from the four steam leads at 4500 lb per square inch and 1150 deg. Fah. is attemperated to 980 deg. Fah. before flowing through resistance orifices to the cooling steam connections. These orifices are in parallel with the first stage nozzles and therefore always proportion the flow to the total throttle flow. The attemperator and controls are shown in Fig. 5. These controls must be extremely reliable so that the machine is neither chilled nor overheated and so that, in the event of trip-out, the water flow is positively shut off to prevent flooding.

The piping for the cooling steam and the four main turbine leads is drained by a common motor-operated drain valve. Good attemperator control is particularly difficult, since the steam pressure in the four main steam leads, and thus in the cooling steam attemperator, is directly proportional to load. This relation exists because the machine is a single-valve machine, with all four valves working together discharging steam at the same pressure to the turbine. At full load 5500 lb per square inch water is available to discharge against the 4500 lb per square inch steam pressure. At half load the steam pressure drops to 2250 lb per square inch and the main feed-water pressure drops only to 4700 lb per square inch. To alleviate this problem two sources of attemperating water are used; one, the main feed-water header, and the other, the low-pressure feed pump discharge. As shown in Fig. 5, a stop valve, situated in each of these water lines, positively shuts off the flow when the turbine trips out. The main steam flow, measured by turbine control valve position and attemperator flow, both modified by cooling steam temperature, act to position the first two valves in the 2200 lb per square inch line until the load reaches such a point that this pressure can no longer supply sufficient attemperating water. The valves in the 5500 lb per square inch line then open to carry the attemperator to full load. Shut-off valves are provided in each line in case of leakage in one or the other of the control stations not in use. A separate temperature trip is provided to trip out the whole unit in the event that the cooling steam temperature goes excessively high or low. A strainer has been provided in the cooling steam line after the attemperator to prevent any foreign particles from entering the machine. Extensive instrumentation has been incorporated in the machine to detect temperatures at various points in the inner and outer shells and around the nozzle assemblies to gauge th effectiveness of the cooling steam arrangements. These temperatures are recorded continuously in the control room.

The primary controls for this machine are similar to those of a conventional machine. All functions are remotely controlled from the main control room. The four stop valves are tripped by solenoid or by action of the emergency governor. These valves may be individually closed for test during full-load operation. Each control valve is positioned by a hydraulic cylinder and they, too, may be closed during operation for test. The stop valves are backseating, so that there will be no stem leakage. The control valves, being positioning, cannot be backseating and therefore have three leak-offs : one, at the first reheat pressure ; one, at the second reheat pressure ; and the last one, at 1 lb per square inch gauge to the steam sealing line. Provision has been made periodically to condense and weigh the first lead-off from the first control valve as a means of checking on the stem and bushing clearance. It has been found that the reduction in the stem leakage is a good measure of the reduction in clearance. The two first reheat intercept valves and the two second reheat intercept valves are positioned by the pre-emergency governor. Reheat stop valves in the second reheat line are tripped shut by the emergency governor. No reheat stop valves are provided in the first reheat line because the potential overspeed of the machine due to failure of the first intercept valves is not serious. The lubricating system utilises a single oil cooler, which is supplied with condensate quality water from the closed turbine auxiliary cooling system. The only important variation from standard control practice is that an initial pressure governor has been provided, not only to act as an overriding control to maintain pressure above a certain level, but, if desired, to act as the sole pressure regulator on the system. Thus the control valves may be positioned either by the initial pressure governor or by the regular speed governor. A turbine by-pass pressure regulator also is provided to control pressure during the starting cycle.

The shafts of the machine are steam-sealed.

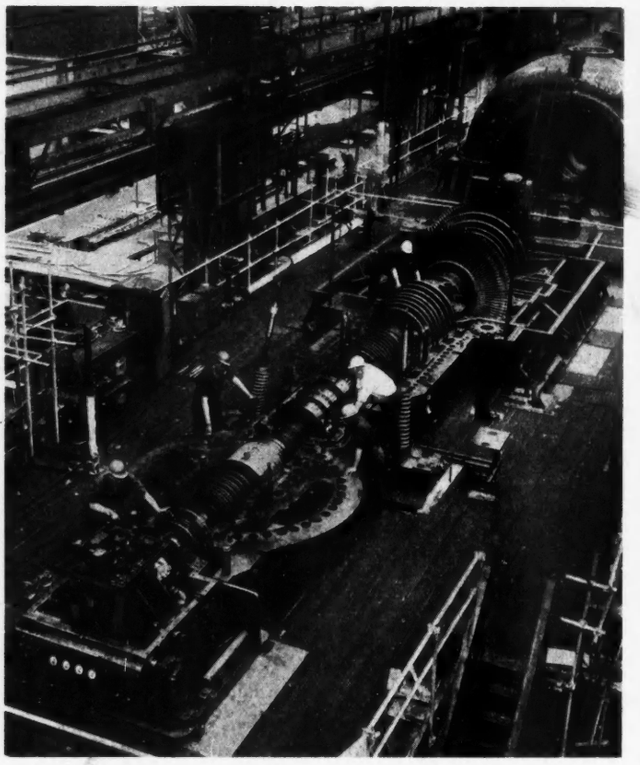


Fig. 6—Erection of 125MW tandem-compound turbine at Philo power station, with high-pressure section in foreground

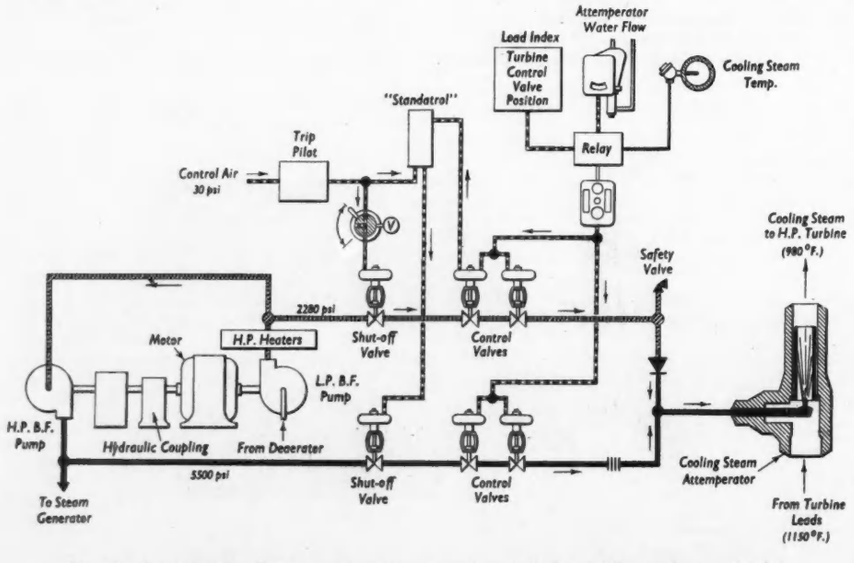


Fig. 5—Arrangement of steam attemperator and controls for turbine cooling application

The steam-seal regulator draws its supply of pegging steam from the by-pass system, which is pressurised both during start-up and shortly after a trip-out. During the short interval after trip-out while the superheater by-pass valve is opening, the shafts are sealed by the steam escaping from the first and second reheaters. Very careful attention has been given to the design of controls which guarantee that the steam-seal regulator pegging valve cannot open unless there is slightly superheated steam available.

Four main steam leads connect to the four stop valves situated under the front of the machine. The leads are 7·70in O.D. by 4·25in I.D. and are made of A.I.S.I. Type 347 columbium-stabilised austenitic stainless steel. Each stop valve serves its own control valve. The whole assembly of stop and control valves is mounted on a rigid frame which is hung on rod hangers. The control gear for the control valves is mounted in a box within the body of this frame so that only a reach rod coming down from the front standard is necessary to position the individual pilots of each control valve mechanism. Steam flows from the control valves through four leads which loop under the turbine foundation arch and up to the high-pressure shell. Steam exhausts from the high-pressure turbine through two 12in lines to the first reheater. First reheat steam returns through two 12in lines, one each to the two first reheat intercept valves mounted on the upper shell of the first reheat turbine. Exhaust from the first reheat turbine returns to the second reheater through two 18in lines. Second reheat steam at 1000 deg. Fah. leaves the reheater through four 16in lines which connect into two 18in lines just before the second reheat stop and intercept valves. One pair of these valves is situated on each side of the stop and control valve assembly. Platforms serve the whole area for ease of maintenance. The second reheat intercept valves are angled out to give a minimum pressure drop and discharge downward into two 20in lines which pass under the turbine arch and into the lower shell of the second reheat turbine. All low points in these lines are drained by air or motor-operated drain valves connected to the drip leg of the condenser.

The 3600 r.p.m. generator is rated 156,250kVA at 15kV, 0·80 power factor, and 30 lb per square inch hydrogen pressure. A 600kW gear-driven exciter operating at 900 r.p.m. and 250V supplies excitation current. In selecting this generator it was realised that machine ratings will continue increasing at least to the point where forced cooling arrangements will prove economical and that power companies should therefore have some operating experience with this type of cooling. The machine therefore has forced cooling of both the rotor and stator. Two pressure systems are used. One is a low-pressure system for ventilating the rotor and stator core. The other is a high-pressure system for ventilating the stator windings. Gas for rotor cooling flows through the rotor and stator core and back to an axial-flow fan. Discharge from this fan flows to the two turbine end coolers and repeats the cycle. A high-pressure centrifugal blower, situated on the outboard end of the rotor, pumps gas through the outboard coolers and then through a header and flexible hose system to each of the stator coils. Warm gas is returned from the turbine end of the machine to close the cycle. The present state of development of blowers required that the fan providing stator coil ventilation be of centrifugal design, larger in diameter than the inside diameter of the stator. This meant that the blower had to be either designed for disassembly or situated on the outboard end of the machine. The latter arrangement was chosen so that the blower could be an integral part of the rotor. This blower and the generator bushings could not be placed at the same end of the generator because of the interference between the taps leading to the bushings and the header and connecting tubes of the high-pressure ventilating system. The generator bushings were therefore moved to the turbine end of the generator. This is not the better arrangement because of the complications of generator leads and hydrogen cooler piping under the generator, but was accepted on this machine with the assurance that on subsequent machines axial-flow blowers of suitable head would be developed so that the blower could be mounted on the turbine end of the rotor.

The generator bushings are hydrogen cooled. On the inside of the copper cylinder, which forms the conducting part of the bushing, is a tube of insulating material which conducts hydrogen from the high-pressure system into the bushing and discharges against the walls of the cylinder before returning to a lower pressure area. At 30 lb per square inch hydrogen pressure the bushings will carry 8000A currents. The hydrogen seals for the shaft use the conventional vacuum system where gas-free oil is injected between floating rings to form the shaft seal. Oil drain lines from the generator bearings are trapped through a vented detraining section to preclude the possibility of hydrogen returning to the main oil tank in the event of shaft seal leakage.

Feed-water Conditioning

From the outset it was recognised that almost perfect control of feed-water conditions was essential to the successful operation of this unit. The initial concepts of the means and quality of this control were outlined and then largely substantiated by observation of German experience with Benson boilers at subcritical pressure and by comprehensive tests carried out on the small supercritical pressure steam generator at the Babcock and Wilcox Research Centre. The first criterion of adequate water quality is that dissolved solids must be kept very low, since any solids carried into the steam generator will be either deposited in the transition zone or carried by the steam into the turbine. Owing to the lack of data on the solubility of various solids in steam, it is possible to conjecture that the presence of solids in the feed-water might result in a greater problem of turbine deposition than steam generator deposition. It was learned that this apparently is the case in the German experience.

The second criterion of quality requires the reduction to a minimum of corrosion not only in the steam generator but also in the feed-water cycle. Any significant quantities of iron oxide in the feed-water would result in deposits within the steam generator. It was decided to limit corrosion by pH control through the addition of ammonia or a suitable amine. The control point has been set and confirmed by test at approximately 9·5. Mechanical de-aeration of the highest efficiency available is utilised and the design of the equipment in the condensate cycle before the de-aerator minimises the possibility of air leakage. In attempting to keep dissolved solids to an absolute minimum all leakage into the cycle must be eliminated as far as possible. The most likely source of this contamination is the condenser. As a result condenser design was directed at obtaining the maximum possible freedom from seepage leaks. Among other arrangements, sprayed rubber coatings were applied to the tube sheets to seal off the rolled tube ends. Cupro-nickel tubes of 70–30 composition were selected as suitable to withstand the high pH conditions on the steam side and the conditions met on the circulating water side so as to minimise tube failures. Similarly, the feed-water heater tubes were for the most part fabricated of 70–30 cupro-nickel.

A multi-purpose demineraliser with a capacity of 100,000 lb per hour has been provided. This can be operated either continuously, by-passing about 20 per cent of the condensate to maintain solids at a minimum or, during start-up or shut-down of the steam generator, to remove any solids which might wash out during these transient conditions. This latter condition of start-up and shut-down governs the capacity of the demineraliser. Although condensate from the old section of the plant is employed as make-up to this unit, it was planned that this water will be "polished" by the demineraliser before use. In addition, filters are included to operate with the demineraliser or singly for by-passing condensate during normal operation or during start-up or shut-down. It has been established that filtration can effectively remove appreciable quantities of iron oxide even at low concentration levels. A test programme designed to evaluate this fact quantitatively and to govern the selection of suitable filter materials was conducted during the design of the plant. In all these considerations there has been the need for information not previously available nor even previously required, such as the organic leaching from resins employed in demineralisation at particularly low concentration levels. Another test was instituted at Philo to gain information on the performance of various alloy condenser tubes in a steam atmosphere approximating that of Unit 6. Three different tube metals (90–10 cupro-nickel, 70–30 cupro-nickel, and arsenical copper) were tested in a small condenser which was tapped into one of the existing units. A second condenser with aluminium tubes and tube sheets was set up in parallel with the first to gain experience with this metal. Particular attention has been paid to develop procedures to clean the steam generator chemically and to operate the unit initially so as to free the cycle of contamination, such as the siliceous material always present after construction. The control conditions contemplated for successful operation are as follows: dissolved solids less than 500 p.p.b. (parts per billion, i.e. 10^9); silica as SiO_2 less than 20 p.p.b.; iron less than 10 p.p.b.; pH 9·5.

Flow Controls

Entirely new concepts are introduced in the control of supercritical-pressure once-through steam generators. The steam generator no longer possesses a tremendous elastic reservoir, the vaporising saturated water, whose pressure is highly sensitive to changes in temperature. Supercritical-pressure water is a homogeneous phase whose properties, such as specific volume and enthalpy, continuously change from those at the feed-water conditions to those at the superheater-outlet conditions. The addition of heat makes the fluid expand in a manner similar to the expansion of a gas, not in the sudden isothermal expansion, which water experiences during evaporation. The pressure in the steam generator must be controlled, therefore, as in a typical flow process by varying either the input pressure or the outlet area. The system pressure is regulated, therefore, either by the variation of the feed-water pressure against an area determined by the control-valve position, or by the variation of turbine-control-valve area with a constant feed-water flow.

Basically, the primary control functions, therefore, are: (*a*) flow determined by turbine control valve position and pressure regulated by feed-pump discharge pressure; or (*b*) flow determined by feed-pump flow and pressure regulated by turbine control valve position; (*c*) and superheater-outlet temperature in either case regulated by heat input to the steam generator. Before the final control arrangements were designed, response tests were run by the Bailey Meter Company on the Babcock and Wilcox test unit. These tests indicated the complete feasibility of the basic control concepts as outlined above.

The feed-water flow and pressure are controlled by the variation of the high-pressure feed-pump speed by a hydraulic coupling. The feed-water flow from each of the two pumps is measured and totalised. Total feed-water flow is also measured by a single flow meter at the steam generator inlet header. The flow is automatically balanced equally between the two pumps. The total flow signal is then balanced against an output from the main superheater header outlet pressure controller and the unit load, as measured by the first-stage bowl pressure in the turbine or against a manual input, to give the corrected signal to position the hydraulic couplings on the feed pumps. When the total flow signal is balanced against a manual input signal selected by the operator, this manual signal becomes the single loading device for the whole unit. During this kind of operation, the feed-water flow is maintained constant and the turbine valves automatically position under action of the initial pressure governor to maintain system pressure. As the control valves respond to this governor, electrical load will fluctuate. This is contrary to the usual governing procedures wherein the control valves are positioned by the operator, and as long as initial pressure and temperature remain constant, the load on the unit is unchanged. It was felt that pressure control by the turbine-control valves might be somewhat faster and more flexible. And, since load variations on the grid system are not intolerable, it was included as an alternative means of pressure regulation.

(*To be concluded*)

Personal and Business

Appointments

MR. O. W. HUMPHREYS has been re-elected president of the Institute of Physics.

MR. G. G. ROBERTS has been appointed technical director of Smiths Aircraft Instruments, Ltd., Cheltenham.

MR. W. C. E. ORR has been appointed manager of the car division of Armstrong Siddeley Motors, Ltd., Coventry.

MR. W. A. T. KENNEDY has been appointed manager of the tractor sales department of Thos. W. Ward, Ltd., Albion Works, Sheffield.

HOLOPHANE, Ltd., announces the appointment of Dr. S. English as chairman in succession to Mr. Guy Campbell, who has retired from the board.

THE INSTITUTE OF WELDING announces that Sir Charles Lillicrap and Mr. J. Strong have been re-elected president and vice-president respectively.

LIEUT.-COLONEL V. I. ROBINS has been appointed director of the National Union of Manufacturers, in succession to Mr. C. F. V. Williams, who has retired.

MR. B. W. LANSDOWNE, A.M.I.Mech.E., has joined Roles and Parker, Ltd., as an account executive. For the past five years he has been editor of *Gas and Oil Power*.

PHILIPS ELECTRICAL, Ltd. (Industrial Division), states that Mr. J. B. Neesam has been appointed filtration engineer and representative for the north-east region.

MR. E. S. HISCOCKS, F.R.I.C., has been appointed director of the United Kingdom Scientific Mission in the British Commonwealth Scientific Office, Washington.

MR. P. W. FAULKNER has been appointed an executive director of the Plessey Company, Ltd. He is general manager of the company's chemical and metallurgical division at Towcester.

MR. T. C. CLEVELAND has been appointed acting manager of the export department of E. K. Cole, Ltd., Southend-on-Sea. Mr. D. G. F. Farmer has been appointed acting export shipping manager.

SHARP CONTOL GEAR, Ltd., Ashby de la Zouch, states that Mr. W. F. Kavanagh, Flat 2, 86, Hampton Road, Twickenham (telephone, Popesgrove 7060), has been appointed representative for London and the Home Counties.

THE ENGLISH ELECTRIC COMPANY, Ltd., announces the appointment of Mr. J. F. Herbert as manager. overseas atomic projects. Mr. Herbert has also been appointed a director of the English Electric Export and Trading Company.

THE NATIONAL COAL BOARD has appointed Mr. A. Walsh, director-general in the industrial relations department, to be deputy chairman of the South Western division, in succession to Mr. H. Lyn Jones, who is retiring on October 31.

JOHNSON AND PHILLIPS, Ltd., states that Mr. E. H. Bennett will take over the duties of managing director of Johnson and Phillips South Africa (Pty.), Ltd., on September 1. Mr. H. L. Dawe has expressed his wish to retire from the office of managing director; he will continue as chairman of the company and as a director of its associate in the Central African Federation, Curling and Co. (Pnt.), Ltd.

Business Announcements

STEDALL AND CO., Ltd., has moved into new premises at Union Works, Carpenter Street, Charles Street, Manchester, 1.

METALASTIK, Ltd., Leicester, has acquired exclusive rights in the United Kingdom for manufacturing the "Stubbe" conveyor.

THE NEWALL ENGINEERING COMPANY, Ltd., Peterborough, has acquired the foundry of James C. Kay and Co., Ltd., Bury, Lancs.

MR. J. F. PERRIN, A.M.I.E.E., has retired from the Air Ministry, after twenty-one years in the A.I.D. and Aeronautical Inspection Service.

JOHN FOWLER AND CO. (LEEDS), Ltd., states that all sales of "Challenger" tractors are now delt with by Marshall Fowler Sales, Britannia Works, Gainsborough, Lincs.

BIRFIELD, Ltd., has acquired the "Railko" engineering bearings and laminates department of Small and Parkes, Ltd. A subsidiary company, entitled Railko, Ltd., has been formed to handle the business.

MARSHALL-HOWLETT, Ltd., 44, Tower Hill, London, E.C.3, is now marketing the conveyor and elevator belting manufactured by Roulunds Fabriker, Ltd., Odense, Denmark.

ROTOL, Ltd., Cheltenham, has formed a new division for the manufacture and sale of turbo-chargers. Mr. W. G. Savory has been appointed general manager of the division.

MONSANTO CHEMICALS, Ltd., states that its operations are now shared between two new divisions, dealing respectively with chemicals and plastics. Mr. D. R. Mackie has been appointed director of the chemicals division and Dr. J. W. Barrett, director of the plastics division.

Contracts

BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., Loughborough, has received an order from the Central Electricity Board of the Federation of Malaya for more than £60,000 worth of equipment. The order, which was placed through the Crown Agents, is for sixty-eight distribution transformers ranging from 100kVA to 1000kVA, and two 4000kVA transformers fitted with Brush resistor tap changers.

THE COPPEE COMPANY (GREAT BRITAIN), Ltd., has obtained a contract for coke oven, chemical by-product plant, and coal preparation plant for the Rhodesian Iron and Steel Company, Ltd.'s steel works extensions at Que Que, Southern Rhodesia. This contract, valued at £1,750,000, has been obtained with the co-operation of the associated company, Powell Duffryn-Coppee, Ltd., 8, Great Tower Street, London, E.C.3.

Miscellanea

INSTITUTE OF WELDING.—The Health and Safety Sub-Committee of the Institute is preparing a series of information sheets under the title "Accidents and their Prevention," and has published No. 1, which is entitled "The Danger of Oxygen Enrichment."

MR. E. G. DYBALL.—We have learned with regret of the death of Mr. Ernest George Dyball, which occurred at Brighton on July 28. Mr. Dyball, who was seventy-seven, was responsible for the formation of The Palnut Company, Ltd., in 1919, and had been chairman and managing director of the company for about thirty-five years.

CONSTRUCTION OF SUPERSONIC TUNNEL.—In our account of the facilities of R.A.E., Bedford, we referred to both the adjustable nozzle of the 8ft by 8ft supersonic tunnel and its associated hydraulics as being manufactured by Costain-John Brown, Ltd. We are now advised by the contractor that the hydraulics were, in fact, mainly the work of Keelavite Rotary Pumps and Motors, Ltd.

EXPORTS OF THE MOTOR INDUSTRIES.—The *Monthly Statistical Review* of the Society of Motor Manufacturers and Traders, Ltd., for July, includes an analysis of exports of all products to all destinations for the three months ended March, 1957. The predominance of sales to the Commonwealth and Empire is less notable (see page 106, July 19) when expressed in value of product, being 54 per cent of a total of £103·8 million.

SELENIUM RECTIFIERS.—We are informed by Standard Telephones and Cables, Ltd., that its "SenTerCel Series 400" range of selenium rectifiers is now in production. Advances are claimed in manufacturing technique and in the size, weight and cost of the product. High-voltage rectifier plates of square form (with or without cooling fins), together with simplified tag arrangements, are thought by the maker to permit economy and flexibility in design.

CONCRETE MOULDS.—A note from Bakelite, Ltd., says that polyester/glass is now being used for making moulds for the production of reinforced concrete slabs and other shapes by Concrete Utilities, Ltd., Great Amwell, Herts. Three types of these moulds made from bakelite polyester resin reinforced with glass fibre material are at present in use. Two are employed for producing reinforced concrete wall panel units and concrete roof trusses for buildings and the third for producing reinforced concrete brackets for street lighting columns. The moulds are claimed to be resistant to corrosion and abrasion and they have a further advantage in being light to handle. Release of the concrete is stated to be easier from a polyester/glass mould than from a steel mould and the moulded shape is given a particularly good surface finish.

INSULATED FLEXIBLE CABLE FOR SURFACE HEATING.—Flexible heating cable for operation at element temperatures up to 450 deg. Cent. is now being produced by Electrothermal Engineering, Ltd., 270, Neville Road, London, E.7. It is intended for use where the same company's tapes or armoured heaters are unsuitable. The cable, known as "Thermocord," has a nickel-chrome element insulated by inorganic fibre. Two feet of insulated unheated lead are attached to each end, and the whole is sheathed in braided glass fibre. The design loading is 5W per inch, and the maker claims that a 24in length, closely coiled round a 1in tube, produces 26W per square inch. The cable has an outside diameter of about $\frac{1}{8}$in and is available in a number of lengths.

CIVIL ENGINEERING MODELS.—A large model of one of the outstanding British civil engineering achievements overseas, the Takoradi Harbour on the Gold Coast, is the central exhibit on the stand "Careers in Civil Engineering," which has been arranged jointly by the Federation of Civil Engineering Contractors and the Institution of Civil Engineers in the industrial pavilion at the Boy Scouts Jamboree at Sutton Coldfield, Birmingham. Booklets and leaflets on "Civil Engineering as a Career" and "Training Schemes in the Civil Engineering Industry" are available at the stand, and a film of various British civil engineering construction works is being shown. The exhibits also include "blown up" photographs of civil engineering works at home and abroad, and a variety of smaller models, including one of the Owen Falls hydro-electric scheme and of various kinds of mechanical plant used in civil engineering construction.

STEEL CASTINGS RESEARCH.—The British Steel Castings Research Association has entered into an arrangement with the Steel Founders' Society of America for the exchange of information at the annual conferences of the two bodies. Each association will, in alternate years, invite the other to nominate a speaker to address its annual conference on a selected subject. The scheme is being initiated this year with an invitation from the S.F.S.A. for representatives of the B.S.C.R.A. to address the S.F.S.A. technical and operating conference in Cleveland, Ohio, in November, on the subject of the application of the graphite-rod resistor furnace to steel foundry practice, and the use in steel foundries of the immersion pyrometer for the measurement of liquid steel temperatures. The B.S.C.R.A. has nominated Mr. T. A. Cosh, head of its steelmaking section, and Mr. L. W. Sanders, chief metallurgist, Lake and Elliot, Ltd., to present this paper.

F.B.I. AND THE CHANNEL TUNNEL.—An announcement made recently in Paris says that a British study group is to be set up to consider the Channel Tunnel project. About this announcement the Federation of British Industries comments that "since the survey is to cover both the engineering and economic aspects of the Channel Tunnel project, the F.B.I. considers it important that those who are supervising the study should include one member who will be able to bring his experience to bear on the problems of the transport-user. It therefore welcomes the inclusion in the group of Mr. E. G. Whitaker, who is a member of the F.B.I. Transport Users' Committee and chairman of its Rail Panel." The Federation also considers that at a later stage in the inquiry it will be necessary to ensure that the economic study of Channel Tunnel possibilities can be compared with an equally thorough review, both practical and economic, of the modernisation of traditional methods of cross-channel transport.

B.B.C. ENGINEERING SUMMER SCHOOL.—A summer school was held, from July 22 to 26, at the B.B.C. Engineering Training Department, Wood Norton, near Evesham. It was attended by thirty-one professors and lecturers from the engineering and physics departments of twenty-six universities and technical colleges in all parts of the country. The object was to give those responsible for the teaching of electrical engineers an opportunity to study the methods used by the B.B.C. and to meet senior B.B.C. engineers and the heads of some of the programme departments, particularly those concerned with the broadcasting of programmes about science in the sound and television services. The training methods used in the engineering division of the B.B.C. were described by the head of the Engineering Training Department, Dr. K. R. Sturley, and members of his staff. Methods used for teaching both fundamental principles and operational methods to B.B.C. staff were illustrated in the laboratories, where training courses of many different kinds are given, both to established staff and to new recruits. The courses vary in length from one week to twelve weeks, and up to 200 resident trainees can be accommodated at one time.

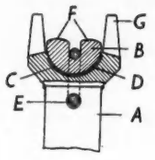
British Patent Specifications

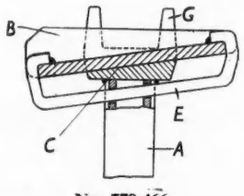
When an invention is communicated from abroad the name and address of the communicator are printed in Italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

MINING ENGINEERING

779,466. May 5, 1955.—METAL PIT PROP, Karl Gerlach and Hans Gerlach, Homberger Strasse, 86, Moers/Niederrhein and Lerchenstrasse, 26, Homburg/Saar, Germany.

According to the invention, there is provided a metal pit prop with a head on its upper end comprising a wedge by means of which the roof girder may be thrust against the roof, which is characterised by the fact that the wedge is designed to pivot transversely to the direction in which it is tightened. The advantage achieved by this construction is that when the roof girder supported by the prop takes up an inclined position, which can occur very easily in mining operations, the girder is prevented from bearing only partly on the prop head, and the edge pressures caused by this inadequate support are avoided. As shown in the drawing, *A* is the top of the pit prop and *B* the transverse wedge mounted on the upper end of the prop. The wedge is pivotable trans-





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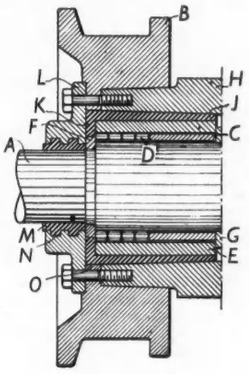
versely to its direction of tightening in a bearing recess *C* in the upper prop *A*, which can be constructed as a normal antifriction bearing in the region of the hatched zone *D*. In this example the wedge *B* is constructed as a channel open at the top, in the recess of which there engages a guide stirrup *E*, whilst the edges *F* of the projecting sides of the channel forming the wedge may be hardened so as to deform the underside of the girder elastically or otherwise when the girder bears on the prop, and thus secure the girder in position in the longitudinal direction. If the girder is in an inclined position the wedge *B* pivots correspondingly in its bearing *C* in such a manner that both edges *F* bear against the girder despite its inclined position. The prop *A* can advantageously be provided with projections *G* on its upper end to hold the girder in position more particularly in the direction of tightening of the wedge. These projections *G* can by means of a stop member be used to secure the girder against movement in its longitudinal direction. A number of modified designs are also shown in the specification.—*July* 24, 1957.

CATERPILLAR TRACTORS

779,468. May 25, 1955.—MOUNTING TRACK ROLLERS ON CATERPILLAR TRACTORS, Karl-Erik Eriksson, Virkesvägen 26, Stockholm, Sweden.

The invention relates to improvements in a device for mounting caterpillar track rollers on tractors, particularly a pair of rollers adapted to support the two edges of the track. Objects of the invention are to provide a resilient mounting, whereby the wear of the rollers and their bearings is reduced, and to provide an almost leakproof seal for the bearings. Referring to the drawings, *A* is a shaft adapted to support two track rollers *B* at a distance from each other, and shows the left-hand side of the mounted track roller, the right-hand side being identical. The shaft portion shown carries a roller bearing. The retainer ring *C* has axial bores extending from both ends and spaced around the periphery. Each bore has a greater diameter than the thickness of the ring. A number of cylindrical bearing members *D* are fitted in each bore. The retainer ring is mounted in such a way that the cylindrical members will engage the shaft directly to roll around it. On its outside the retainer ring *C* is surrounded by a race ring *E* supported by the bearing members *D*. A washer *F* is mounted on a step of the shaft to form an axial support for the members *D* at the end of the retainer ring turned outwardly and another washer *G* is placed at the inner end of the ring to support the members as well as the race ring *E* axially. The opposite side of the washer *G* forms a support for the outer cylinder member, not shown. The two track rollers *B* are mounted on a common sleeve *H* having a greater inner diameter than the outer diameter of the race ring *E*. Externally, the sleeve tapers conically towards both its ends to enable the track rollers to be secured by wedge action. Internally, the sleeve is widened conically towards its ends. A collar *J* of rubber is inserted into the space between the sleeve *H* and the race ring *E*. The collar is tapered in correspondence with the inner wall of the sleeve and is



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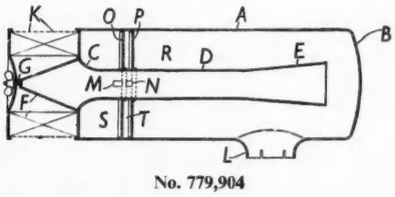
tightly fitted to constitute a resilient radial support. The outer end of the collar is provided with a flange *K* to form a support for the outer end of the race ring *E*. Outside the track roller *D* the shaft *A* is surrounded by a collar *L*, the inside of which has two peripheral grooves for receiving corresponding ribs *N* of an inserted packing ring *M* of rubber. The collar *L* is provided with a number of axial holes and bolts inserted through these holes are tightened to press the collar against the roller and the flange of the rubber collar *J*. A certain resilient mounting of the track rollers obtained by this arrangement reduces the effect of shocks to such an extent that the life of the bearing is considerably increased. An additional reason of the reduced wear is the tightness of the device, whereby dirt and the like are prevented from penetrating into the bearings. A hub cap, not shown, is generally provided outside the collar, but dirt may nevertheless gradually penetrate between the shaft and the surrounding packing ring *M*. However, the flange *K* forms, together with the washer *F*, an effective barrier against further penetration.—*July* 24, 1957.

INTERNAL COMBUSTION ENGINES

779,904. September 9, 1954.—SILENCERS FOR GASEOUS CURRENTS, Vokes, Ltd., Henley Park, Guildford, Surrey. (*Inventor: Gordon Heatherton Vokes.*)

As seen in the drawing, an air inlet filter and silencer with a generally cylindrical casing *A* has one end *B* closed while its other end provides a curvilinear tapering inlet passage *C* which increases the velocity of the gas flow to a concentric air inlet tube. This tube has a central parallel-sided section *D*, but terminates in a flared outlet section *E* so as to constitute a venturi. A bridge piece *F* spanning the



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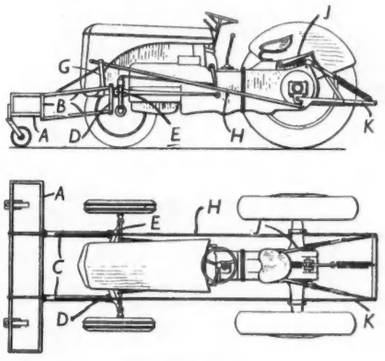
mouth of the inlet tube serves to anchor a bolt *G* which with a wing nut and end cap locates a crimped cylindrical air filter unit *K* and a perforated metal cover. The inlet tube at its narrower central section is about one-quarter of the diameter of the cylindrical casing and terminates some distance from its closed end. The annular space *R* between the inlet tube and the casing constitutes a low-pressure chamber and a radial conduit *L* in the wall of the casing constitutes an outlet from the chamber to the inlet of an engine. A pair of slots *M* and *N* cut in the wall of the inlet tube towards its inlet end give access to a pair of resonant chambers *S* and *T* of predetermined capacity, and each of dimensions smaller than those of the low-pressure chamber formed by annular baffles or division plates *O* and *P* fitted between the tube and the casing. These chambers are designed to attenuate sound of a frequency resonant to the length of the inlet tube itself and of a harmonic of this frequency. In operation air drawn in by engine suction is first filtered on radial passage through the crimped cylindrical filter *K* and is then diverted axially down the venturi inlet tube to the surrounding low-pressure chamber *R*. Sound resonant to the tuned length of the venturi tube is attenuated in the small capacity resonant chambers *S* and *T* about the inlet end of the tube. The relative high velocity of air flow through the central portion of the inlet tube is found in practice to have a marked effect upon the overall efficiency of the silencer. The application of the principle to an exhaust silencer is also described in the specification.—*July* 24, 1957.

AGRICULTURAL MACHINERY

778,773. July 25, 1952.—TOOL BARS FOR AGRICULTURAL TRACTORS, Gordon Vernon Clark, Norton Priory, Norton, Malton, Yorkshire.

This invention relates to tool bars for agricultural tractors having power-lift mechanisms and has for its chief object to provide a tool bar which can be mounted on the front of a tractor. A further object is to provide a controlling mechanism which will ensure that the tool bar lifts in a horizontal position. Referring to the drawing, the tool bar consists of a rectangular frame *A* having a pair of spaced vertical members *B*, to each of which are pivotally connected



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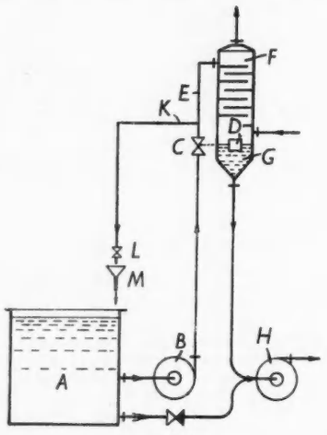
a pair of parallel raising and lowering bars *C* in turn connected to fixed brackets *D* mounted on the front wheel mounting shaft *E* of the tractor. From the raising and lowering bars or levers *C* project a pair of levers *G*, which are connected by their upper ends to pull bars *H* one on each side of the tractor, which have their ends pivotally connected to the power lift mechanism *J* of the tractor through the medium of rear brackets *K*. The pull bars *H* are adjustable between the levers *G* and rear brackets *K* by means of holes. The raising and lowering bars or levers *C* are interchangeable with an alternative set or sets of bars or levers of varying length so that the distance between the tool bar and tractor can be varied to suit requirements The tool bar by reason of its parallel arm mounting lifts vertically in a horizontal position and is given adequate lift for avoiding plants, and as a result of it quick mounting enables accurate and front field work to be accomplished.—*July* 10, 1957.

STEAM GENERATORS

778,571. March 12, 1956.—BOILER FEED WATER DEAERATION SYSTEMS, Heinz Backhaus, 13, Spiegelgasse, Vienna 1, Austria.

In the drawing, a storage tank containing untreated water is shown at *A*. A feeder pump *B* connected to the tank by a pipe draws aerated water and feeds it, in the required amount, through a regulating valve *C* having a float *D*. From the valve a water inlet pipe *E* leads to a de-aerating cascade *F*, where the water is heated by steam to boiling temperature and de-aerated. The de-aerated water then collects in the collecting reservoir *G*, where the level is controlled by the float and regulating valve so that it remains substantially constant. From the reservoir a second feed pump *H* conveys the required amount of de-aerated water into a boiler. If there is a failure of water supply from the collecting reservoir *G* the feed pump *H* can also draw water directly from the storage tank. A pipe *K* is connected to the pipe *E* between the regulating valve and the de-aerating cascade *F* and in this pipe is a butterfly valve *L* for controlling the amount of water flowing back to the storage tank. The pipe *K* leads into the storage water tank *A* located before the feeder pump in the system. It is

advantageous to locate an open funnel *M* between the valve *L* and the tank so that the boiler attendant can verify that the water circulation through pipe *K* is functioning normally. In the arrangement described the regulating valve *C* is throttled by the float *D* only so that when the level of water in the collecting



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reservoir *G* rises, the inflow into the de-aerating cascade *F* is slowed down or stopped entirely ; however, the throttling does not go so far as to stop the flow of water through the pipe *K*. Consequently the feeder pump always conveys a certain minimum amount of water, so that the regulating valve and the feed pump are not harmfully strained.—*July* 10, 1957.

Technical Reports

The Detection of Weld Flaws in Chain Links. By J. Deakin, B.Sc. Safety in Mines Research Establishment Report No. 135. H.M. Stationery Office. Price 2s. 9d.—This report describes experimental work which was carried out to ascertain whether it is practical to apply methods of non-destructive testing to the inspection of colliery haulage and winding chains. It describes the weld defects which may be associated with wrought iron and steel chains and states that traditional or purely visual methods of inspection were shown to be inadequate in many of the samples investigated. The report describes in detail various methods for the non-destructive detection of flaws, including radiographic, magnetic electric and acoustic methods. It recommends tests which would ensure that only reliable chains are put into service, and which would detect faults developed during service.

Trawler Icing Research. The British Shipbuilding Research Association, 5, Chesterfield Gardens, Curzon Street, London, W.1.—The report describes experiments carried out to measure the loss in stability of a trawler model due to icing. A normally rigged model was used and tests were made in the head to wind, stern to wind, and head 30 deg. of wind conditions. Tests were also made with the model fitted tripod foremast. Although the weight of ice and icing pattern are considered to be generally similar to that encountered at sea, the rate of icing on the model cannot be related to actual conditions, since no information on time scales and icing intensity is available. The tests are mainly comparative, but do indicate the relative icing encountered and its effect on stability. The report reviews the nature and effects of icing at sea and the problem and possible methods of protection. The tests were carried out by Vickers-Armstrongs (Aircraft), Ltd., and Vickers-Armstrongs (Shipbuilders), Ltd., in the climatic chamber at Weybridge.

Flow Instability of Centre-Body Diffusers at Supersonic Speeds. By D. Beastall. *Reports and Memoranda No.* 2933. H.M. Stationery Office. Price 3s. 6d.—This note offers explanations for certain kinds of flow instability which occur with centre-body diffusers at supersonic speeds. These instabilities manifest themselves as oscillations of the shock pattern ahead of, and the flow through, the diffuser for certain conditions of operation and are likely to affect the performance seriously. Two main types of oscillation have been distinguished : a violent oscillation which occurs when the flow through the diffuser is throttled below a certain value ; a less severe oscillation which occurs when the vortex sheet from the intersection of the shock waves ahead of the diffuser or a separated boundary layer strikes the cowl.

The explanations of the oscillations are substantiated by schlieren photographs of two and three-dimensional model diffuser tests in a wind tunnel. It seems possible in the light of the explanation given in this note, to be able to predict the range of instability of any centre-body diffuser configuration by fairly simple model tests.

The Structure and Properties of Cadmium Titanate and Sodium Tantalate (Ref. L/T333). By J. L. Miles. The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey. Price 15s., postage 4d.—The aims of the research described in this report were threefold. First, to grow crystals of materials of the barium titanate group in an untwinned condition, suitable for X-ray structure analysis. Secondly, to perform the structure calculations. Thirdly, to interpret the physical properties of the material in terms of the bonding revealed by the structure analysis.

The first two objects were achieved and a fair measure of success was obtained with the third. The report on the growth of crystals was incorporated in report L/T303, and is not repeated in the report reviewed here.

The By-pass Purification of Lubricating Oil and Other Liquids. Sharples Report No. 2475. Sharples Centrifuges, Ltd., Camberley, Surrey.—A mathematical treatment of the problem of the by-pass purification of lubricating oil, as practised, for example, in diesel engines and machine tools. There is a discussion of the particular case of the batch purification of liquids and a comparison of the effectiveness of circulatory batch purification with two vessel batch purification. Finally, it is shown that there is an optimum throughput for operation of a centrifuge, or in fact, any kind of clarifying purifier. It is shown that for severe purification problems the high efficiency tubular bowl centrifuge is to be preferred to the disc machine, the actual rate of circulation being relatively unimportant.

Les Transmissions de Puissance et la Variation de la Vitesse. By P. Patin. Eyrolles, Editeur, 61, Boulevard St. Germain, Paris (5e). Price Fr. 3300.—Throughout the mechanical field, power transmissions are found based on a variety of fundamental principles and in a great number of different designs. The present book gives a survey of the most important forms of transmission and examines them both from the theoretical and the practical design points of view.

Launches and Trial Trips

JEAN MERMOZ, passenger liner ; built by the Chantiers de l'Atlantique (Penhoët-Loire) for Cie de Navigation Fraissenet et Fabre ; length overall 572ft 3in, length between perpendiculars 492ft 1½in, breadth moulded 64ft 10in, depth to upper deck 43ft 3in, loaded summer draught 22ft 9in, deadweight 5900 tons, service speed 16·75 knots ; first-class passengers 144, second- and third-class passengers 886 ; five holds, two 8-ton and eight 5-ton derricks, electric winches ; four 525kW and one 100kW diesel-driven generators, one 100kW emergency generator ; two seven-cylinder Penhoët - B. and W. mark 762VTBF.15 two-stroke, single-acting, supercharged diesel engines, 10,600 total h.p. at 130 r.p.m., heavy fuel. Trial, May.

TOBAGO, cargo ship ; built by the Chantiers Réunis Loire-Normandie for the Compagnie des Transports Océaniques ; length overall 474ft 11in, length between perpendiculars 446ft 2½in, breadth moulded 62ft 5in, depth to shelter deck 36ft 9in, draught loaded 25ft 4in, deadweight 9100 tons, loaded service speed at 23ft 7in draught 16 knots ; two 340kW and one 160kW generators ; Schneider-B. and W. supercharged, single-acting, two-stroke diesel engine, 7500 h.p. at 115 r.p.m. Trial, May.

NORTHBANK, cargo ship ; built by W. Doxford and Sons (Shipbuilders), Ltd., for the Bank Line, Ltd. ; length between perpendiculars 450ft, breadth moulded 62ft, depth moulded to upper deck 38ft 6in, deadweight (closed shelter deck) 11,980 tons ; five holds, one 25-ton, four 10-ton, ten 5-ton and two 3-ton derricks, electric winches ; Doxford opposed-piston oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, 6180 b.h.p. Trial, June 4.

TRINCULO, ore carrier ; built at Wallsend by Swan, Hunter and Wigham Richardson, Ltd., for the Bowring Steamship Company, Ltd.; length overall 505ft, length between perpendiculars 480ft, breadth moulded 69ft, depth moulded 38ft 3in, summer draught 27ft 6½in, deadweight 14,600 tons, service speed 13½ knots ; four ore holds, single pull MacGregor hatch covers, wing ballast tanks, steam winches ; Wallsend-Doxford opposed-piston, two-stroke, diaphragm oil engine, four cylinders, 670mm diameter by 2320mm combined stroke, 4350 b.h.p. at 115 r.p.m., heavy fuel, two multi-tubular Scotch boilers. Trial, June 5.

AEGEAN ISLAND, closed shelter deck cargo ship ; built by the Burntisland Shipbuilding Company, Ltd., for the Aquila Compania Naviera S.A. Panama ; length between perpendiculars 435ft, breadth 59ft 9½in, depth moulded 39ft 6in, deadweight 11,900 tons, draught 29ft 2½in ; five cargo holds, one 30-ton, six 10-ton and four 5-ton derricks, electric deck machinery ; three 200kW and one 40kW diesel-driven generators ; Kincaid - B. and W. two-cycle, single-acting diesel engine, seven cylinders, 620mm diameter by 1870mm combined stroke, 5500 b.h.p. at 120 r.p.m. Trial, June 6.

CRESTBANK, cargo liner ; built at Belfast by Harland and Wolff, Ltd., for Andrew Weir and Co., Ltd.; length overall 483ft, length between perpendiculars 450ft, breadth moulded 62ft 6in, depth moulded 38ft 6in, gross tonnage 6460 ; two complete steel decks, five cargo holds, one 25-ton, two 10-ton, twelve 5-ton and two 3-ton derricks, electric winches ; three 175kW diesel-driven generators ; Harland and Wolff single-acting, two-stroke, opposed-piston diesel engine, six cylinders, 620mm diameter by 1870mm combined stroke, 118 r.p.m., heavy oil fuel. Trial, June 7.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

INCORPORATED PLANT ENGINEERS

Tues., Sept. 3.—LONDON BRANCH : Royal Society of Arts, John Adam Street, Adelphi, Strand, London, W.C.2, "Maximum Demand and Power Factor and their Effect on the Electricity Tariff," T. A. Williams, 7 p.m. ★ EDINBURGH BRANCH : 25, Charlotte Square, Edinburgh, Members' Evening, 7 p.m.

Wed., Sept. 4.—LEICESTER BRANCH : Bell Hotel, Leicester, "The Painting of Buildings," R. Woodwards, 7 p.m.

Mon., Sept. 9.—DUNDEE BRANCH : Mathers Hotel, Dundee, "Variable-Speed Drives with Voltage Regulation Equipment," 7.30 p.m. ★ MERSEYSIDE AND N. WALES BRANCH : The Blossoms, City Road, Chester, "The Cost Accountant and the Plant Engineer," R. G. Hall and B. J. Willson, 7.15 p.m.

Tues., Sept. 10.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, Chairman's "At Home," 7.15 p.m.

Wed., Sept. 11.—W. BRANCH : Grand Hotel, Bristol, "Fire Prevention in Industrial Buildings," 7.15 p.m.

Thurs., Sept. 12.—GLASGOW BRANCH : Scottish Building Centre, Glasgow, "The Design and Application of Rotary and Reciprocating Air Compressors," W. Scott, 7.15 p.m. ★ N.E. BRANCH : Roadway House, Oxford Street, Newcastle upon Tyne, "Internal Combustion Engines as Applicable to Plant Engineering," Norman Parry, 7 p.m.

Tues., Sept. 17.—BIRMINGHAM BRANCH : Hotel Leofric, Coventry, "Titanium as a Material of Construction in the Chemical Industry," K. W. J. Bowen, 7.30 p.m.

Wed., Sept. 18.—KENT BRANCH : King's Head Hotel, High Street, Rochester, Ladies' Film Evening, 7 p.m.

Thurs., Sept. 19.—BLACKBURN BRANCH : Golden Lion Hotel, Blackburn, Joint Meeting with Institute of Fuel, "Fuel and Power Position in the United Kingdom," Rear-Admiral Sir Sidney Frew, 7.30 p.m.

Tues., Sept. 24.—GLASGOW BRANCH : Scottish Building Centre, 425–427, Sauchiehall Street, Glasgow, Joint Meeting with the Institution of Heating and Ventilating Engineers, "Steam," and "Combustion and the Chain Grate Stoker," 7.15 p.m. ★ S. WALES BRANCH : South Wales Engineers' Institute, Park Place, Cardiff, "Metal Degreasing by Trichloroethylene," and "Metal Pretreatment in Industry," 7.15 p.m.

Thurs., Sept. 26.—SHEFFIELD AND DISTRICT BRANCH : Grand Hotel, Sheffield, "The Design of Rolling Mills, with particular reference to Hot and Cold Ferrous Mills," M. Langen, 7.30 p.m.

Fri., Sept. 27.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, "Some Principles of Radiant Heating," P. A. Coles, 7.30 p.m.

Mon., Sept. 30.—W. AND E. YORKSHIRE BRANCH : Leeds University, "The Safe Use of Electricity," J. J. Emerson, 7.30 p.m.

INSTITUTE OF METALS

Mon. to Fri., Sept. 16 *to* 20.—Forty-ninth Annual Autumn Meeting, 1957, to be held in Glasgow.

INSTITUTE OF THE MOTOR INDUSTRY

Sat. to Sat., Aug. 24 *to* 31.—St. Catharine's College, Cambridge, Eleventh Annual Summer School.

INSTITUTION OF MECHANICAL ENGINEERS

Sat., Aug. 31.—S. BRANCH : Whole-day visit to the pumping stations of the Mid-Wessex Water Company, Frimley, Surrey.

Sat., Sept. 14.—SOUTHERN BRANCH : Whole-day visit to the Greenham Common base of the United States Air Force, Newbury, Berks, 10 a.m.

IRON AND STEEL INSTITUTE

Wed. and Thurs., Sept. 25 *and* 26.—IRON AND STEEL ENGINEERS' GROUP : Church House, Westminster, London, S.W.1, "Air Pollution in the Iron and Steel Industry."

MANCHESTER GEOLOGICAL AND MINING SOCIETY

Thurs., Oct. 10.—Mining and Technical College, Wigan, Annual General Meeting, 3.30 p.m.

ROYAL AERONAUTICAL SOCIETY

Fri., Sept. 13.—FORTY-FIFTH WILBUR WRIGHT MEMORIAL LECTURE : Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, "Advanced Education and Academic Research in Aeronautics, Clark B. Millikan, 6 p.m.

SOCIETY FOR WATER TREATMENT AND EXAMINATION

Wed. to Fri., Oct. 2 *to* 4.—Palace Hotel, Southend-on-Sea, Autumn Meeting.

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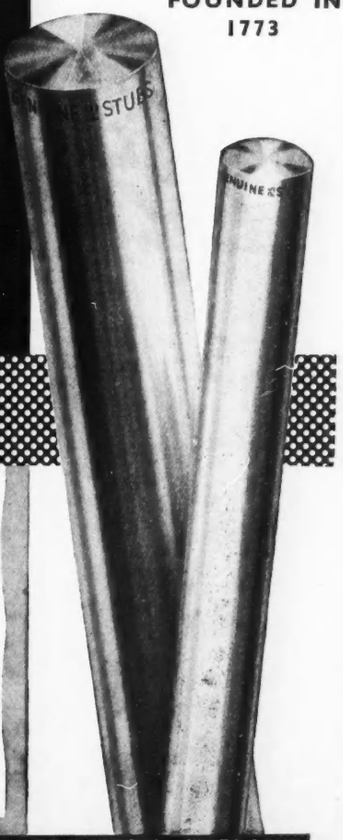

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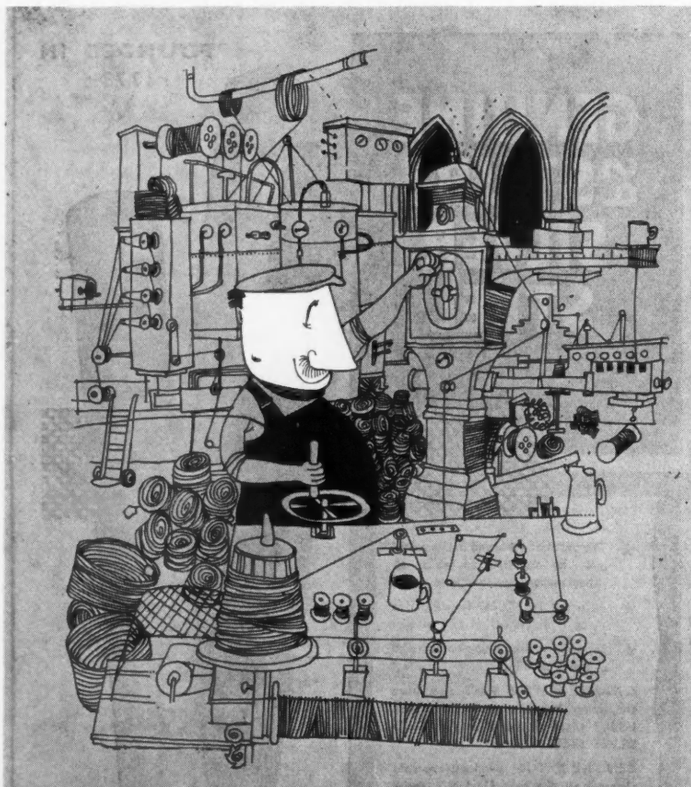

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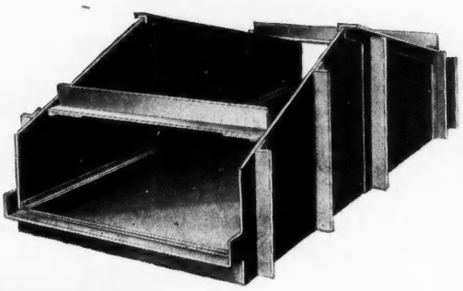

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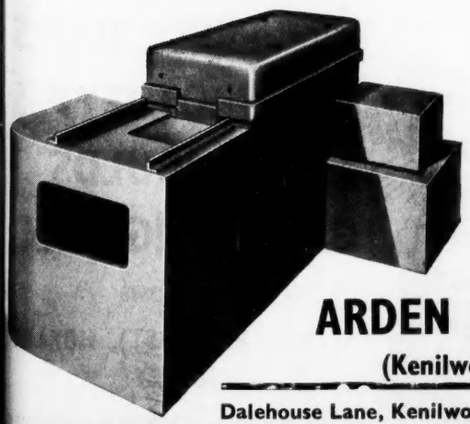

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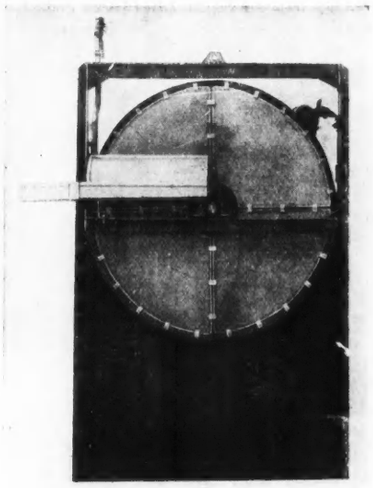

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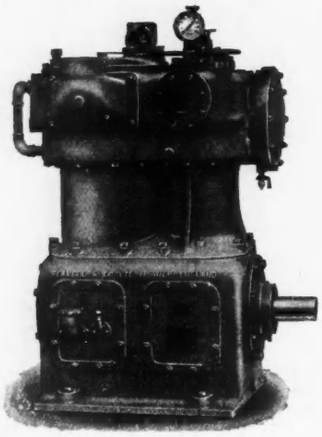

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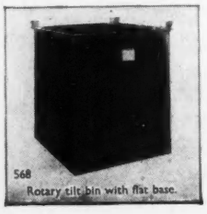

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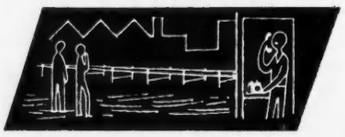

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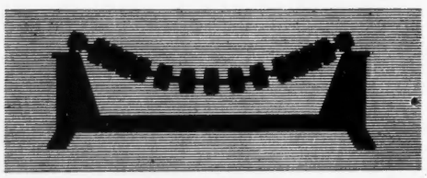

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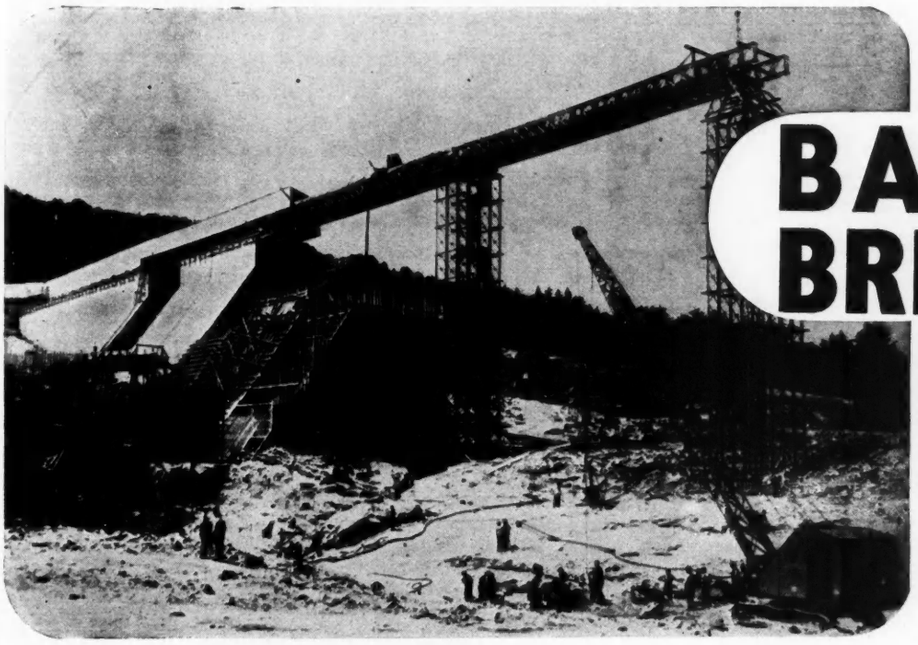

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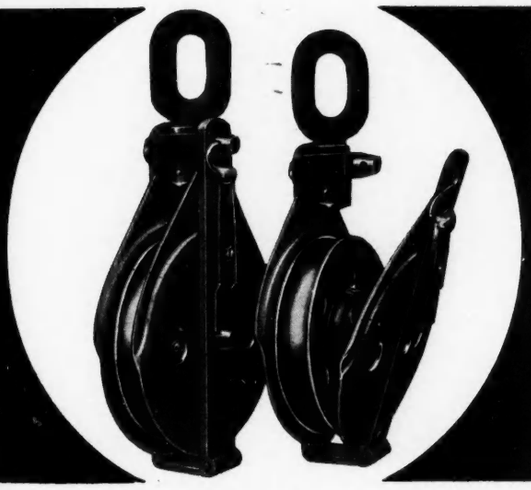

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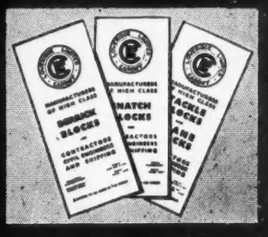

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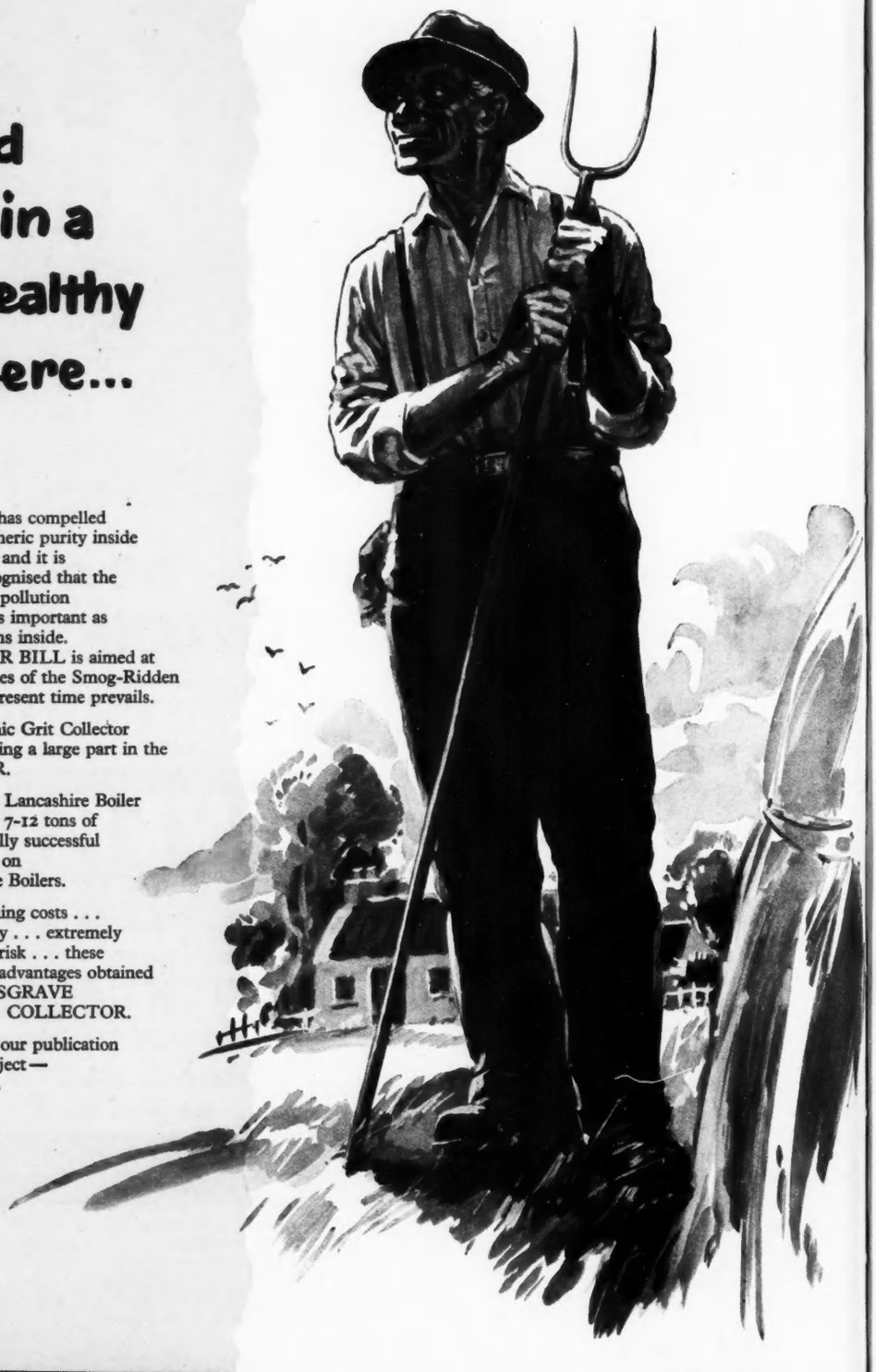

In recent years legislation has compelled a high standard of atmospheric purity inside factories and workshops — and it is becoming increasingly recognised that the prevention of atmospheric pollution outside such buildings is as important as maintaining good conditions inside. The proposed CLEAN AIR BILL is aimed at clearing our towns and cities of the Smog-Ridden atmosphere which at the present time prevails.

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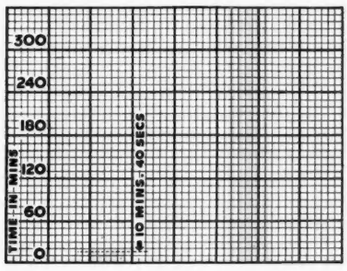
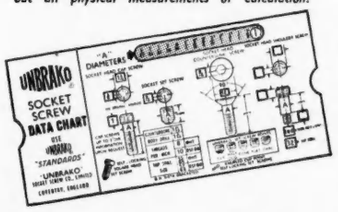
Vibration test of self-locking set screw

The divisions between the horizontal lines on the graph represent intervals of 60 minutes. Each vertical band represents a screw tested when subjected to vibrations at the rate of 1,750 cycles per minute. It can be seen that the Plain Cup Point screws most favourable duration test was 10 minutes 40 seconds, before shaking loose. The Knurled Cup Point screws remained tight after 300 minutes — representing 525,000 cycles of vibration — after which tests were discontinued.



Write for this **FREE DATA CHART**

In the drawing office, in the toolroom or on production — you'll save valuable time and avoid costly guess-work with this free data chart, it cuts out all physical measurements or calculation.



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Throughout the world, Unbrako precision is the standard by which all other screws are judged. And this self-locking set screw is another guarantee of Unbrako leadership. Unbrako self-locking set screws cannot be damaged by tightening and removal, and the knurled point does not damage the shaft. You can use them again and again, and the unique design with the exclusive knurled cup point shows in tests that it can stand more than 28 times the vibration that shakes loose ordinary plain cup pointed screws. Where considerable vibration must be contended with, you need Unbrako self-locking set screws. Details will gladly be supplied on request.

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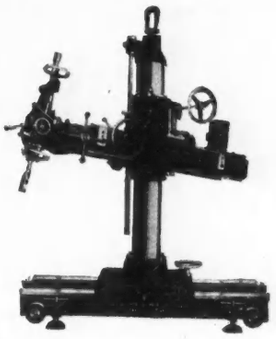

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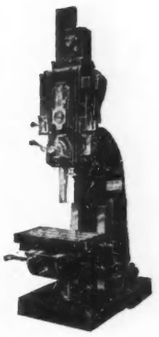

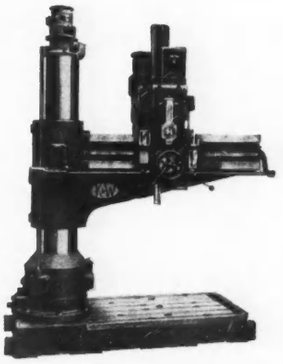

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Mechanised mould and core making plant

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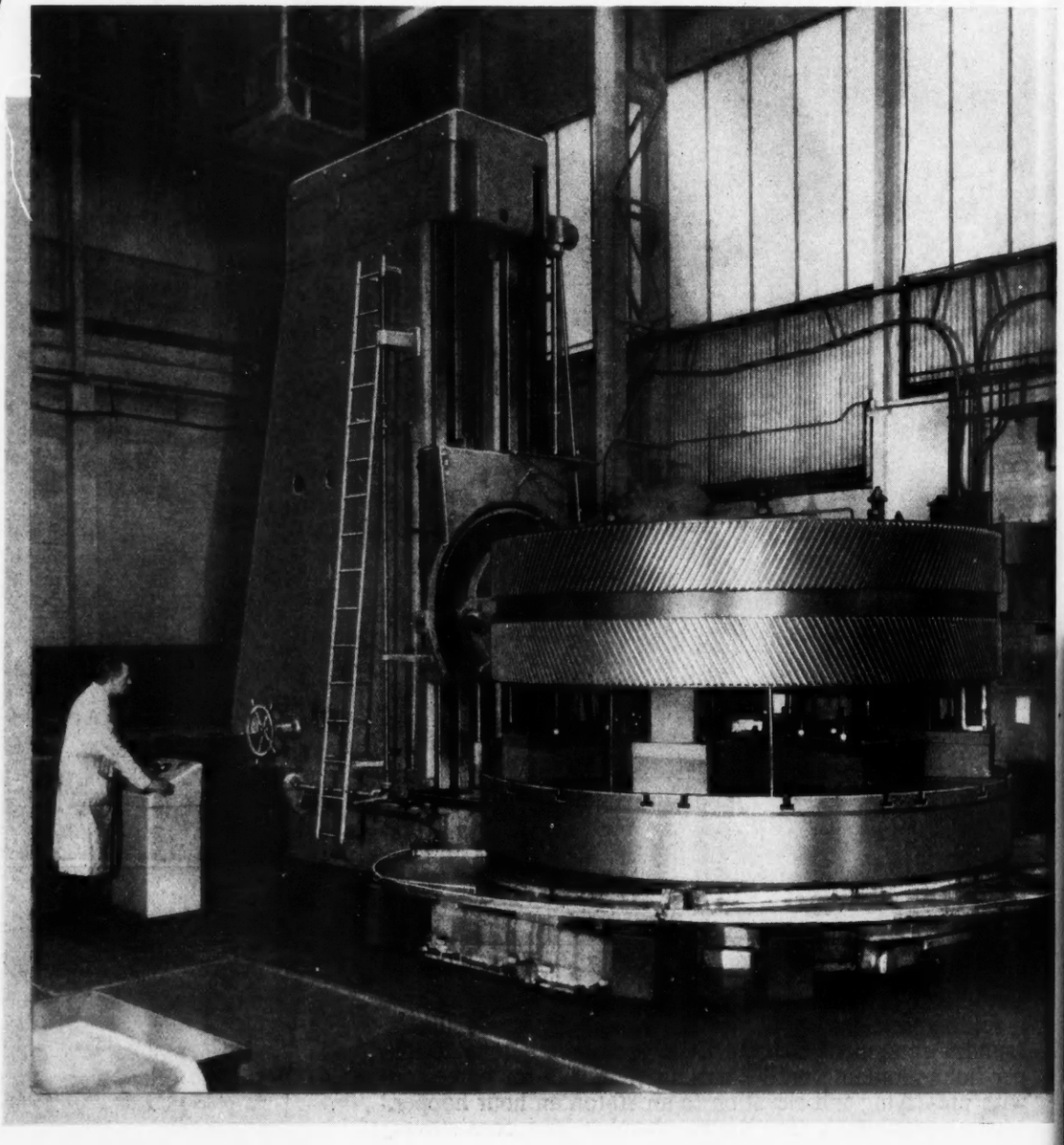

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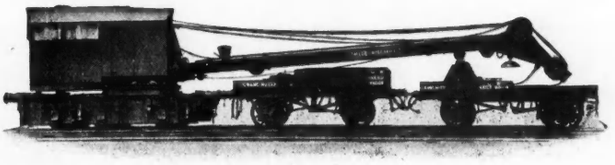
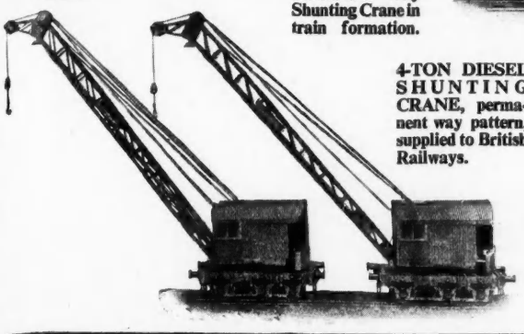


10-ton Diesel Permanent Way Shunting Crane in train formation.



4-TON DIESEL SHUNTING CRANE, permanent way pattern, supplied to British Railways.

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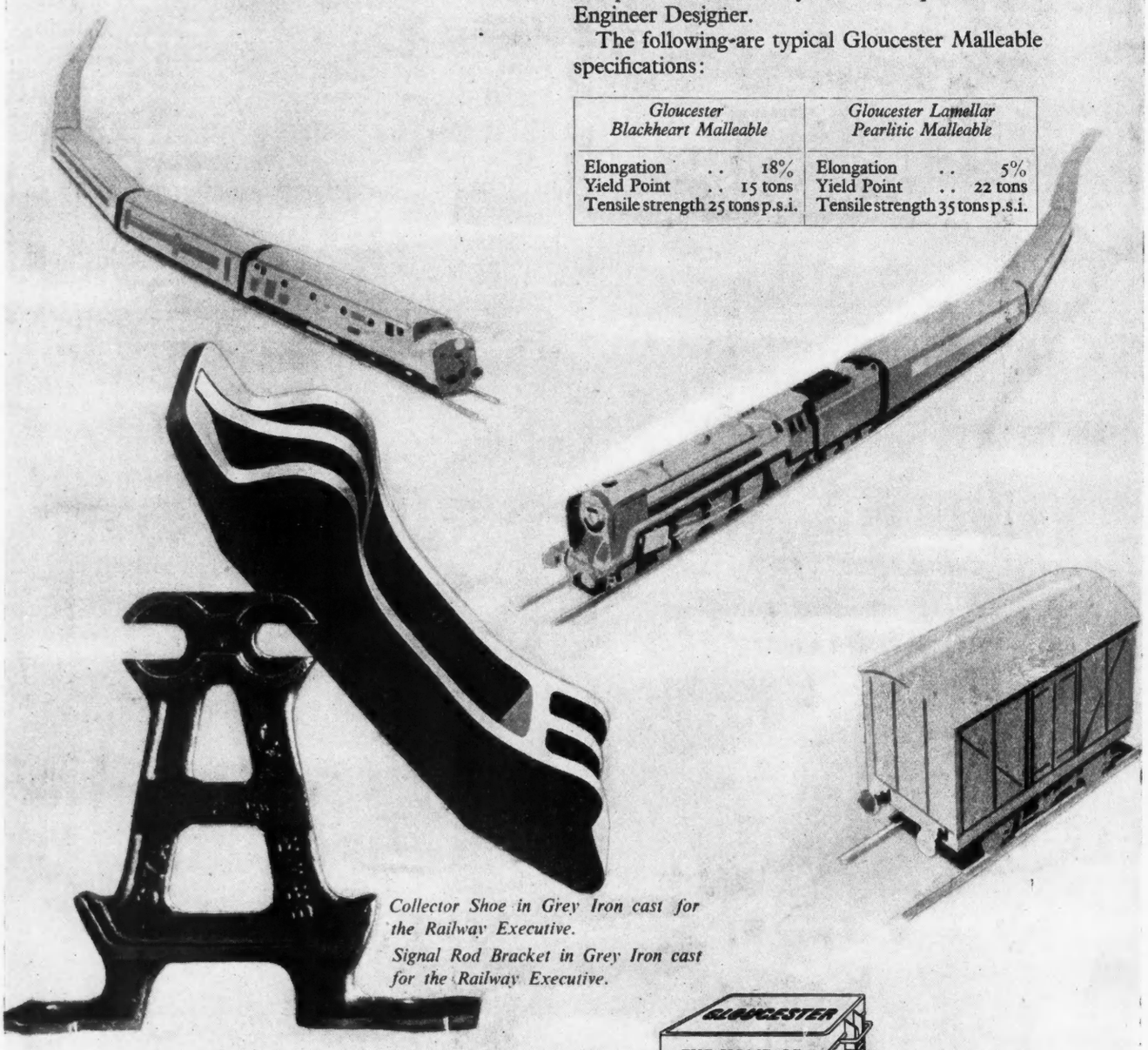

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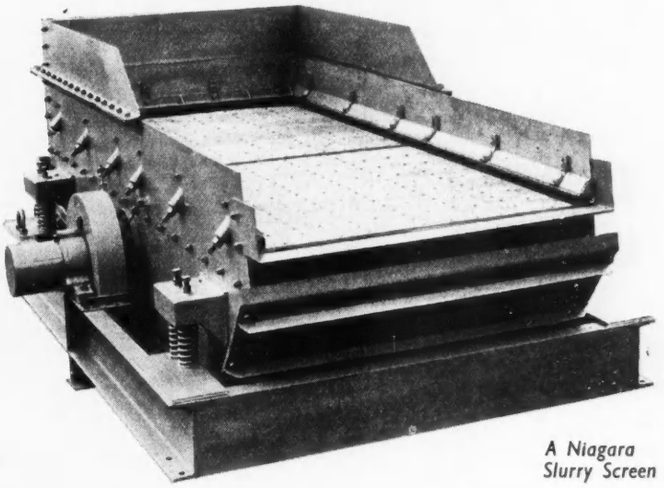

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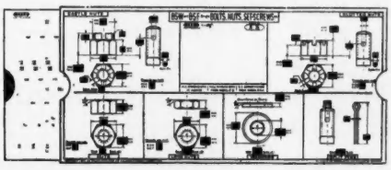
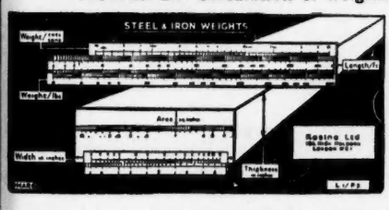


MODEL L.I. Calculation of weights of steel sections



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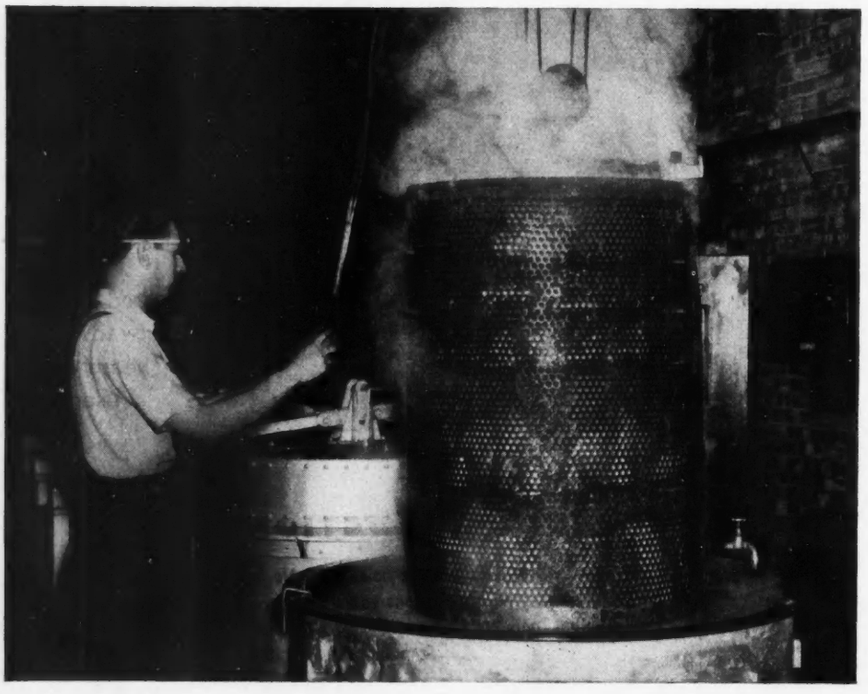

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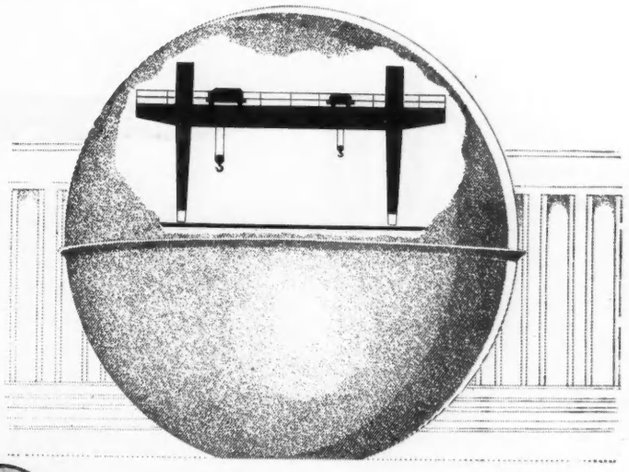

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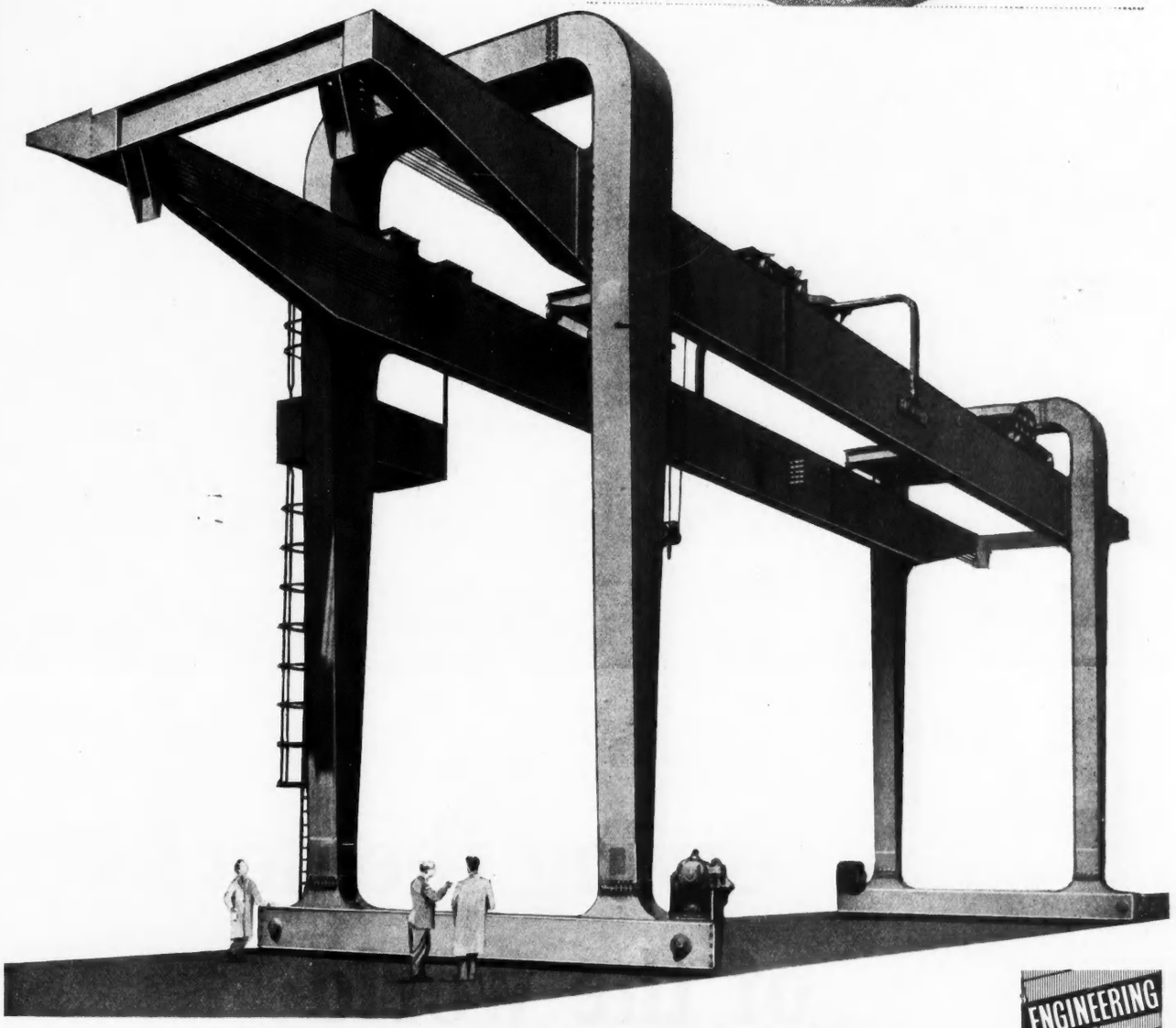

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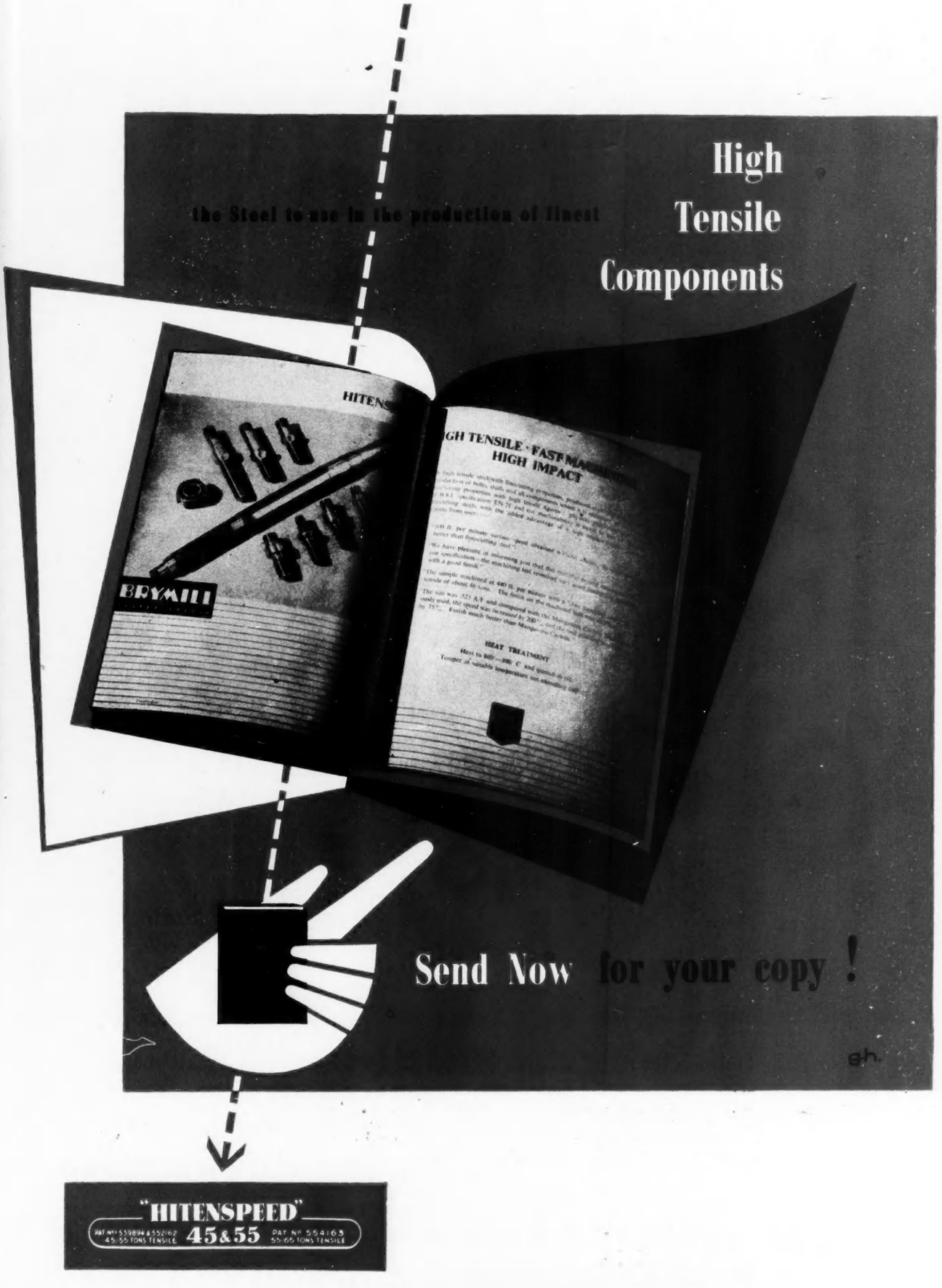

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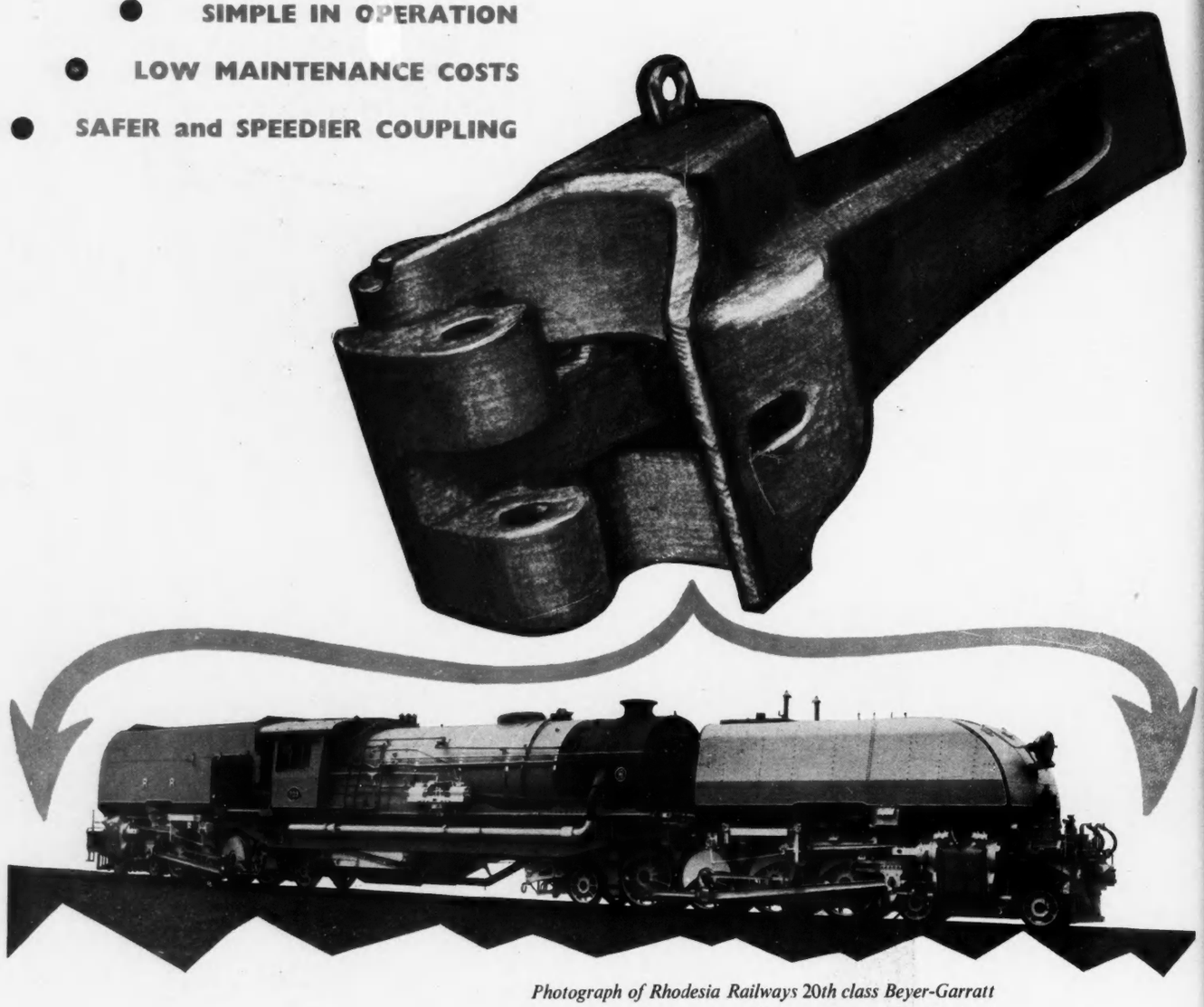

Photograph of Rhodesia Railways 20th class Beyer-Garratt Locomotive—By courtesy of Beyer Peacock & Co., Ltd.

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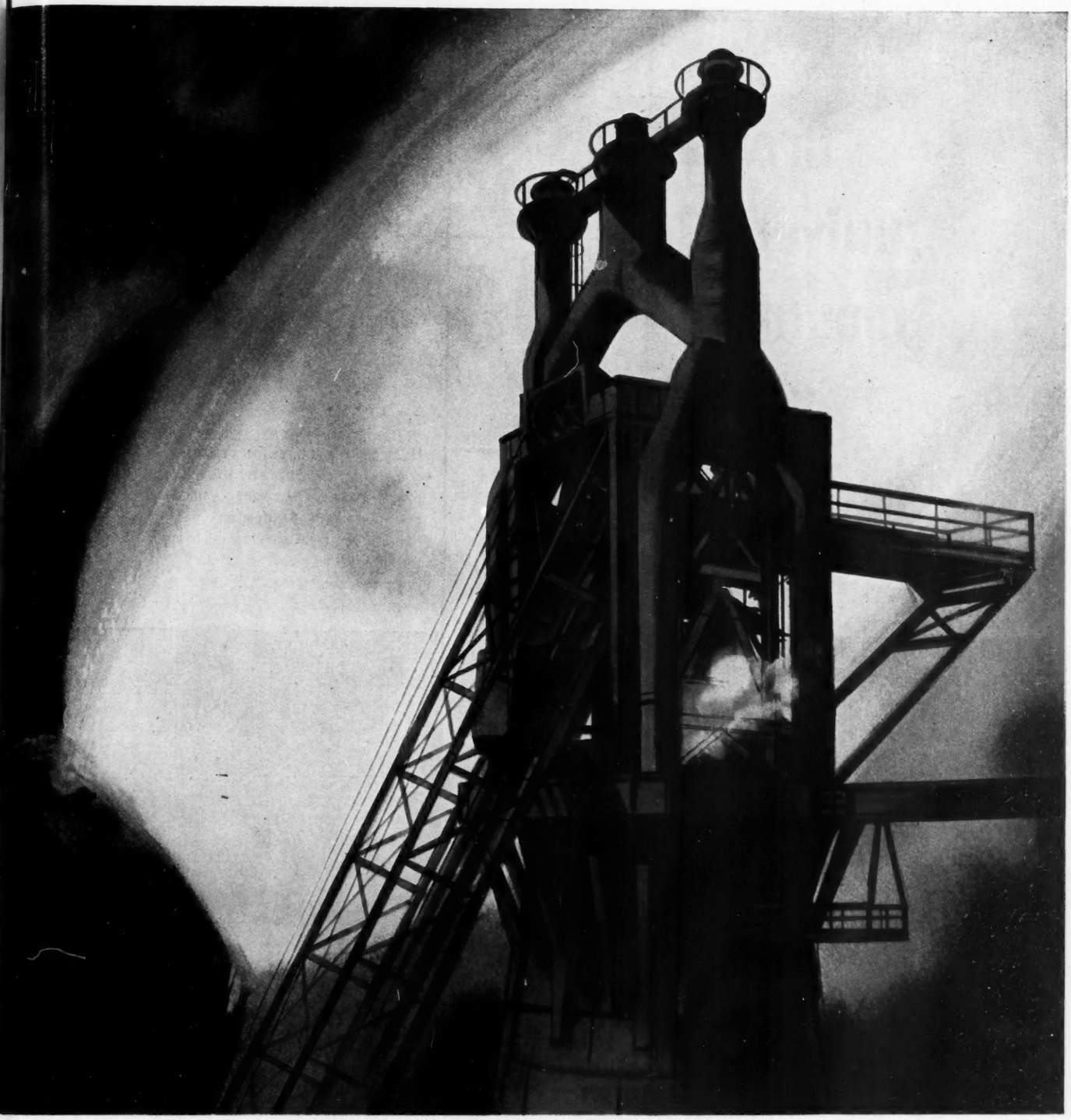

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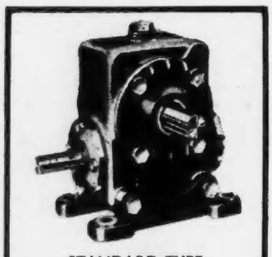
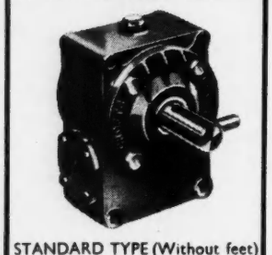
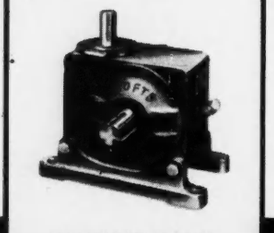
Crofts universal mounting worm reduction gears



STANDARD TYPE

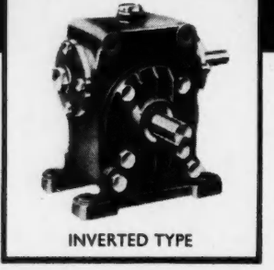


STANDARD TYPE (Without feet)



'D' MOUNTING TYPE

VERTICAL TYPE



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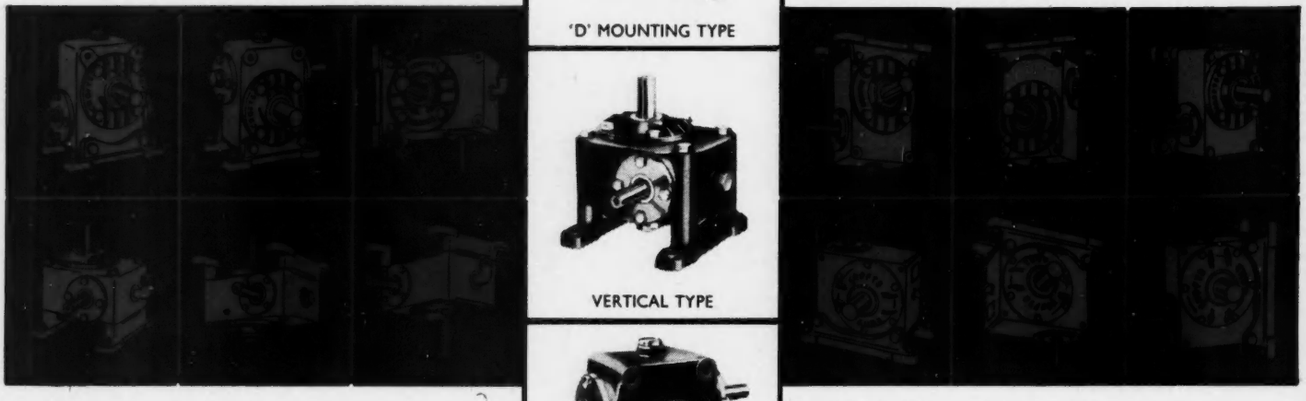

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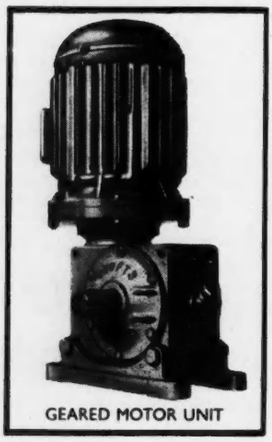

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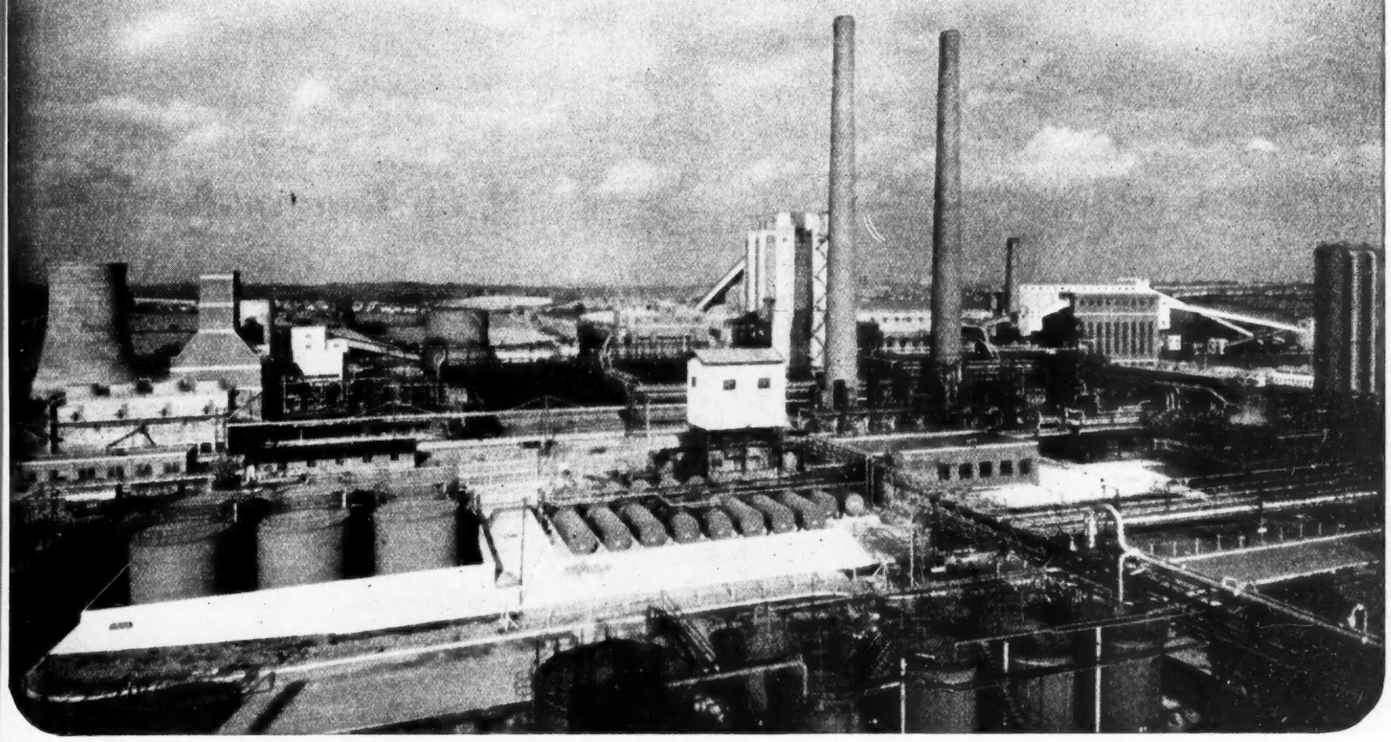

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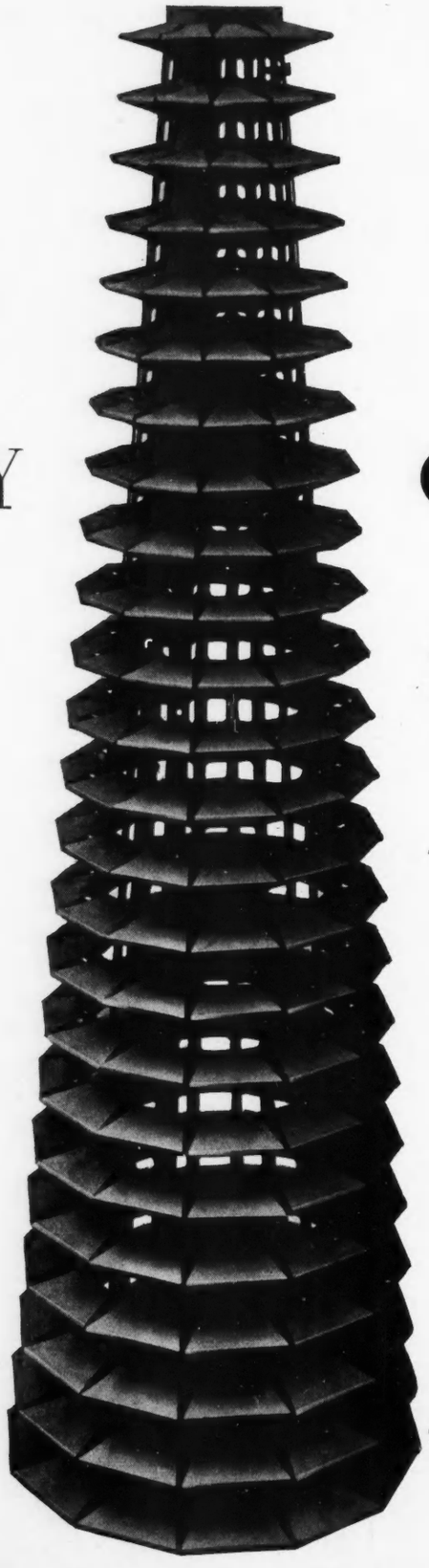

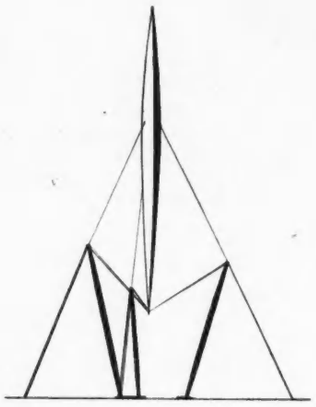

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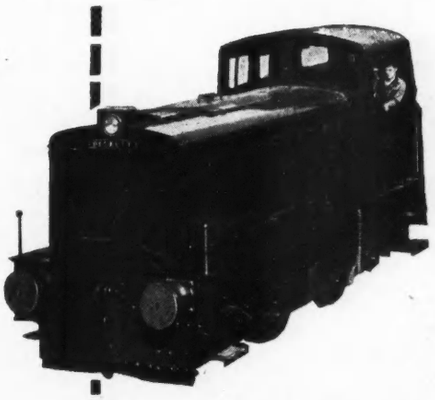

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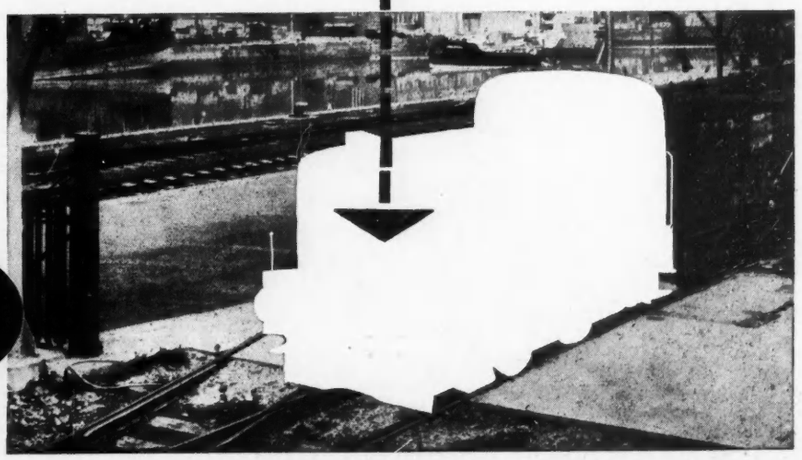

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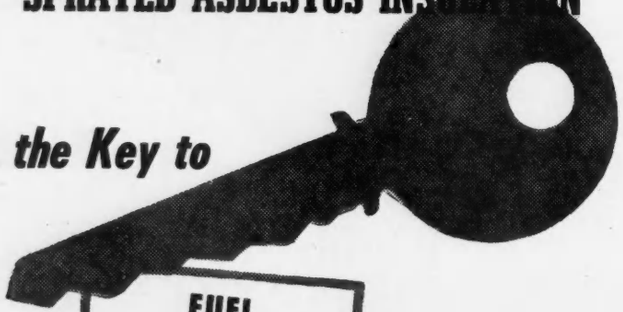

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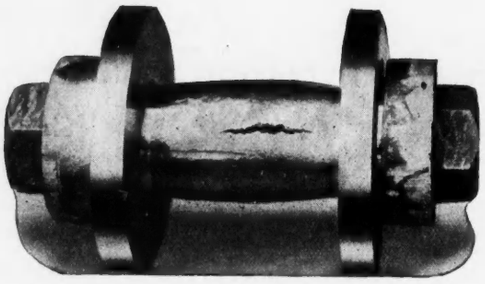
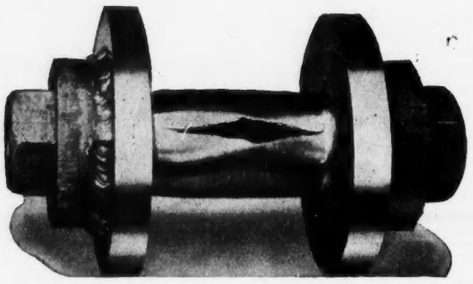


Gun-metal **0·25 in.** *thick—burst at* **4480** *lbs. per sq. in.*



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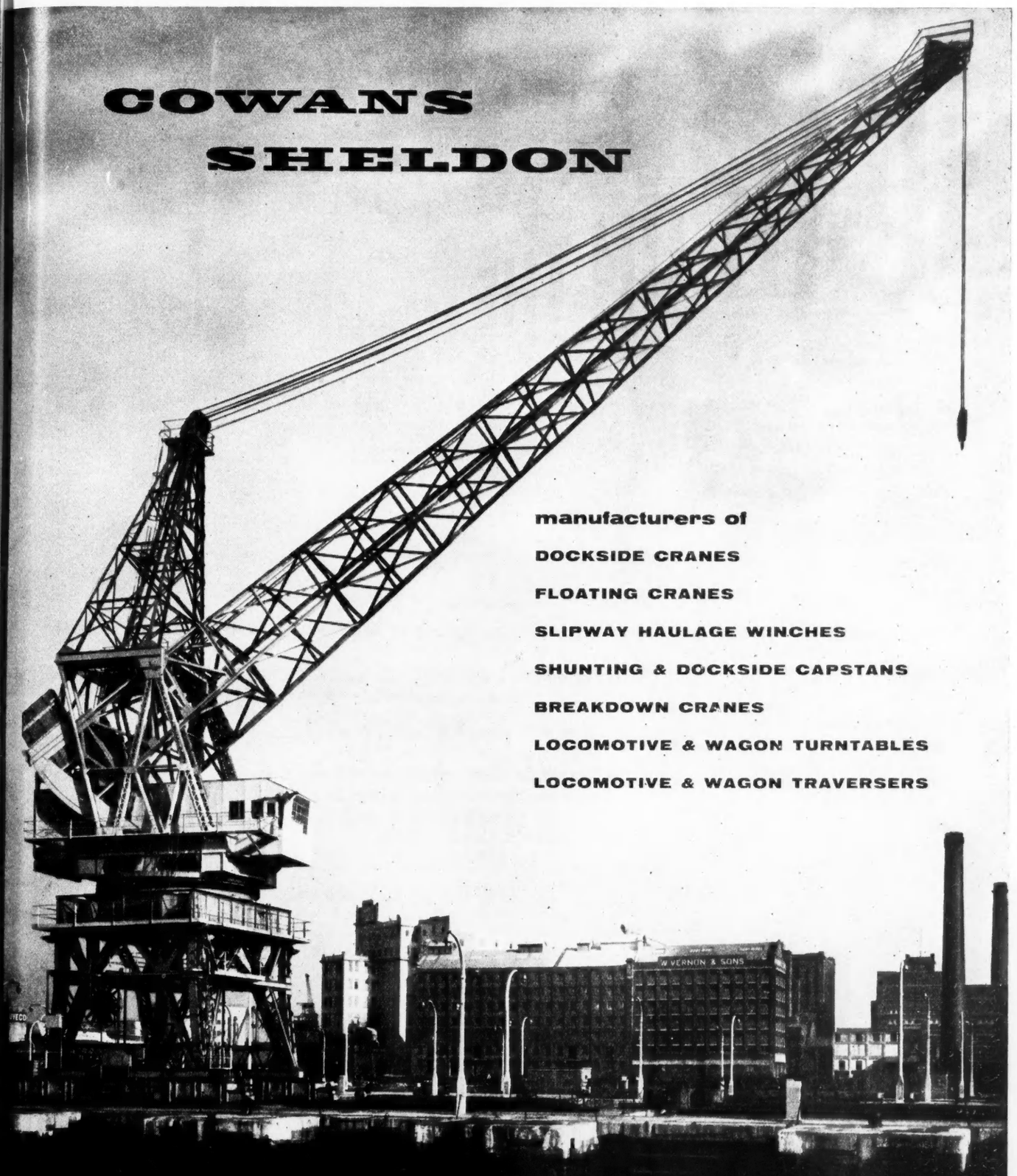

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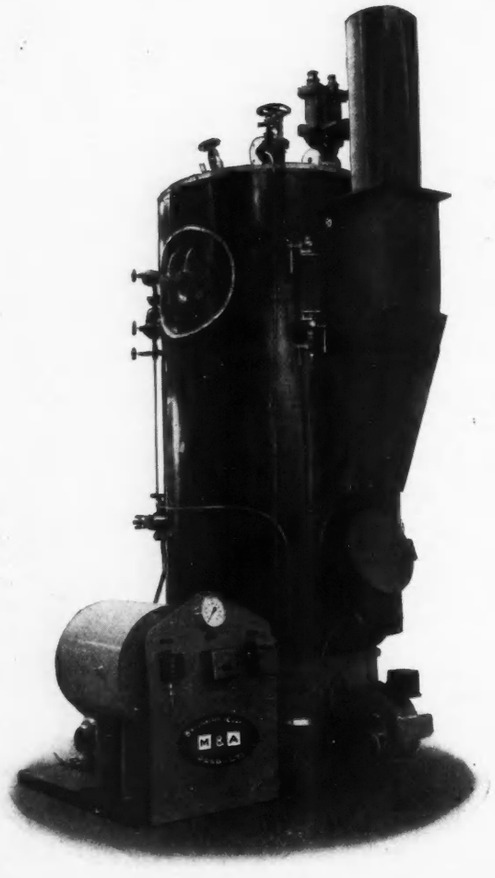

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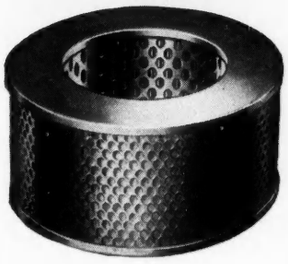

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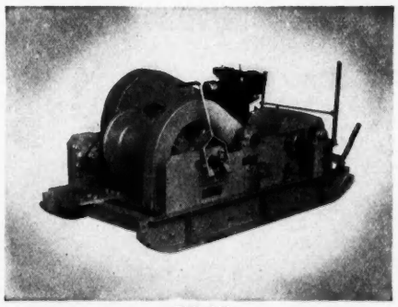

FIG. 229
Petrol driven two-speed hoist giving hoisting speeds of 10 and 30 ft/min. with a maximum load of one ton. Used for the erection of steel pylons, the hoist is mounted on skids, it is arranged for self propulsion by pulling on an anchored rope through a return block.

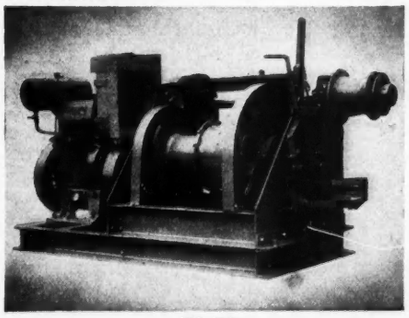

FIG. 228
Diesel driven winch with a divided barrel of two diameters and one warping drum, used for cargo handling on coastal motor ships.

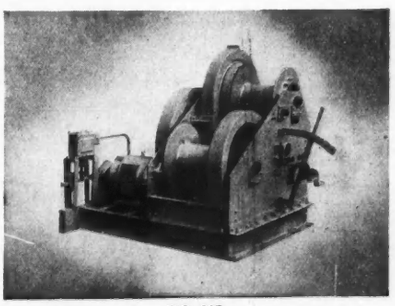

FIG. 227
One of a pair of Electrical reversible hoists specially designed to be accommodated within a confined space; one being right hand as illustrated and the other left hand; each hoist fitted with a solenoid operated brake as well as foot brakes, each barrel being suitable for a 3½ ton load; used in connection with a screw piling outfit.

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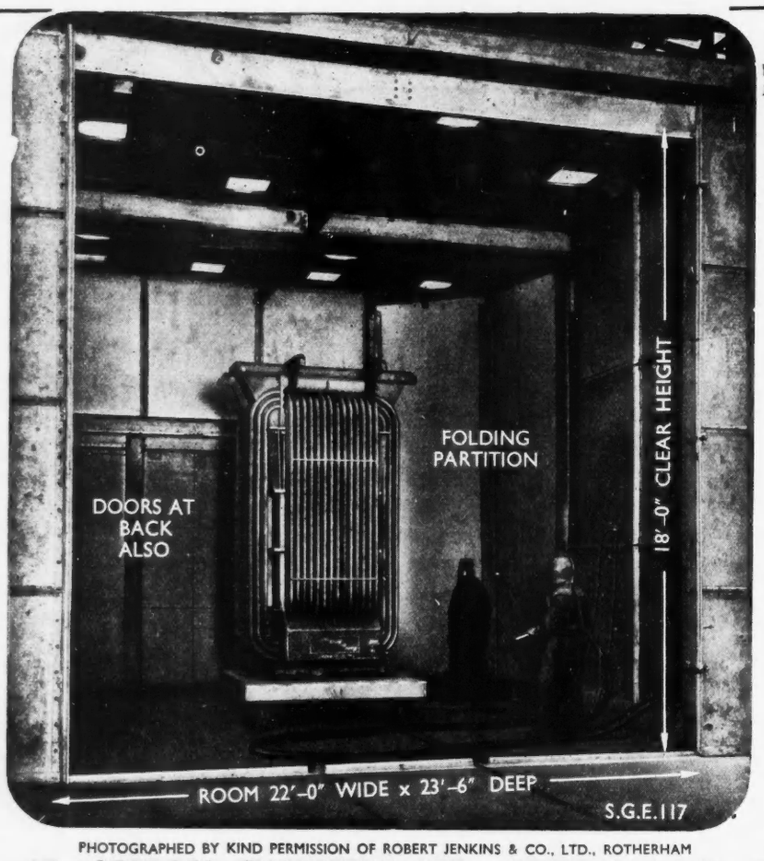

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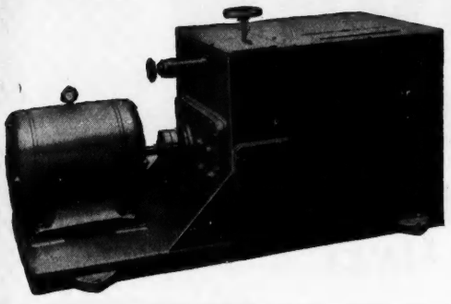

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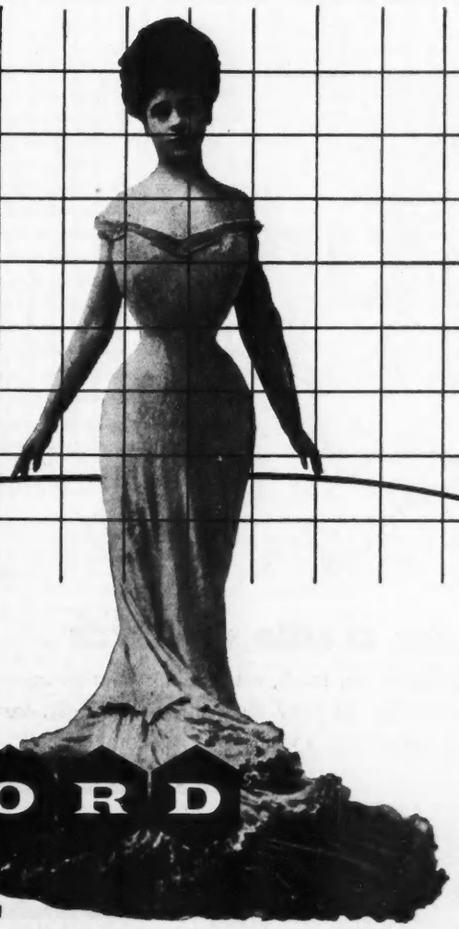

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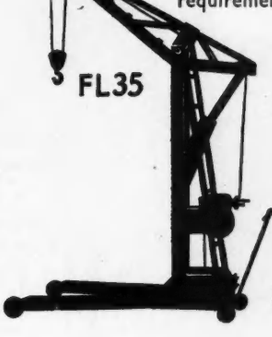
A 30-cwt. JACK CRANE with patent telescopic jib. This is an improved model of the original FJ.30, giving extra height of lift and reach while the overall height is reduced. Capacity 10-30 cwt.

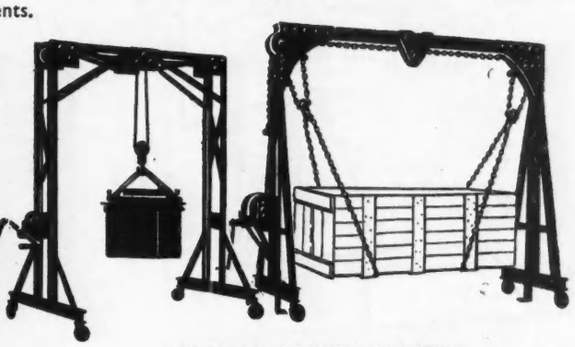
FJ.40.
Similar in construction to the FJ.30A but with a capacity of 10-40 cwt.

FL.35.
Has an adjustable jib for high lifts, easily operated by one man. All welded construction. Four-point base for stability.

FJ.15A.
A smaller model of the FJ.30A. Shows jib flat on ground for use as high lift jack. Capacity 5-15 cwt.

FJ.20.
Similar in construction to the FJ.15A but with a capacity of 15-20 cwt.





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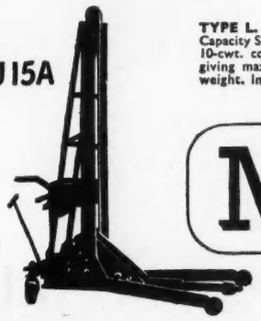

TYPE L.
Capacity Side lift load 20-cwt.; centre lift 10-cwt. constructed on lattice principle giving maximum rigidity with minimum weight. Indispensable to busy workshops.

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A heavier model for dealing with side lifts of 60-cwt. and centre lift of 30-cwt. Special chain assembly provided for side lifts

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The filtering elements are static; they do not move. Each filtering element is thoroughly flushed with cleaning fluid. No carry over of cleaning fluid. Continuous Cleaning providing constant water gauge resistance and high cleaning efficiency. High ratio of nett area to overall area. Low power consumption. Adaptable to any size, and formation.

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This filter provides a maximum efficiency with complete reliability in service. Its filtering surface area is 46 times the face area. The filtering elements are rigidly supported in the cell frame. They do not become displaced by vibration or movement and provide a uniform air velocity over the face area. It is non-clogging providing a constant water gauge resistance. It is adaptable to any size or formation.

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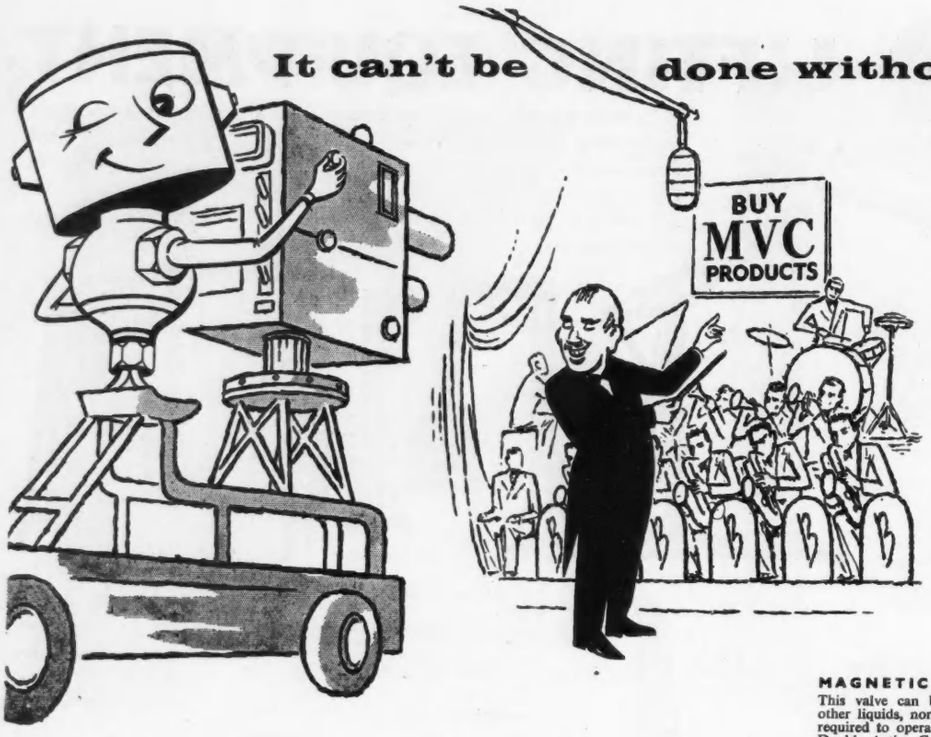

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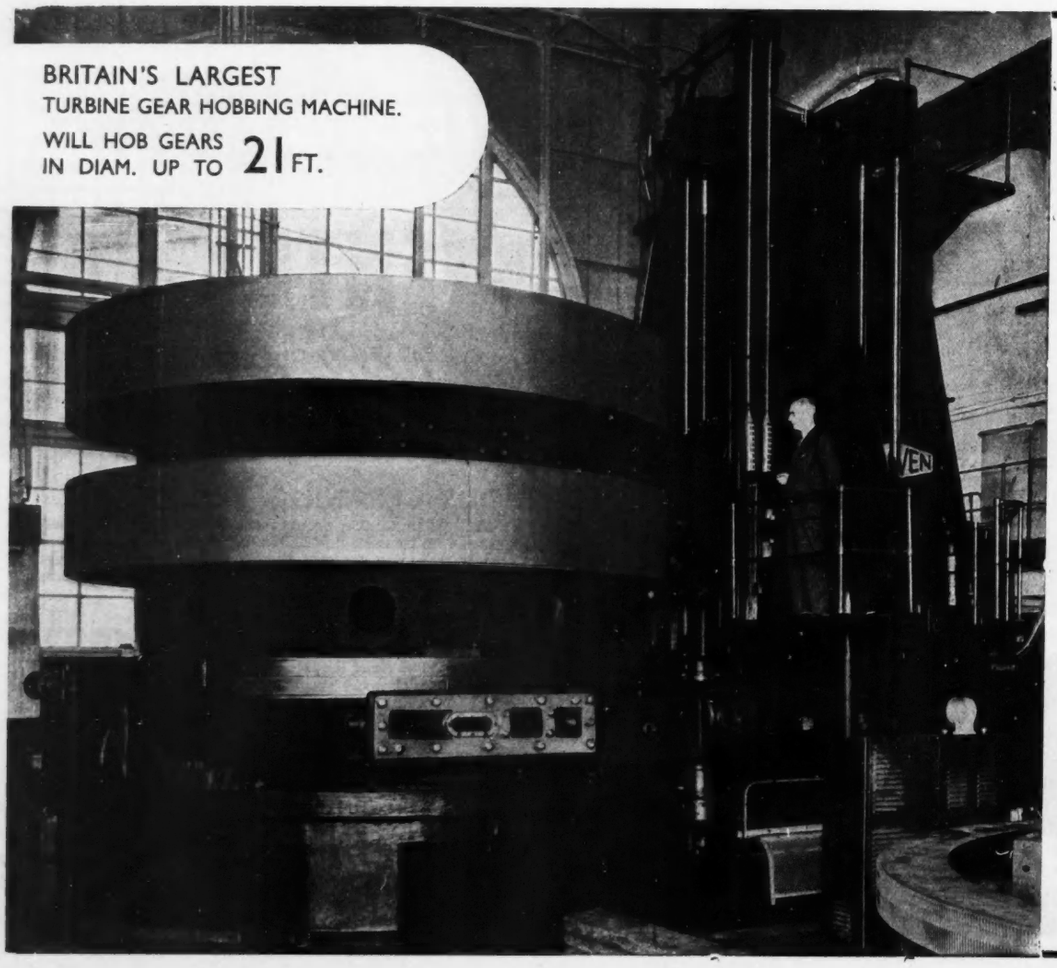

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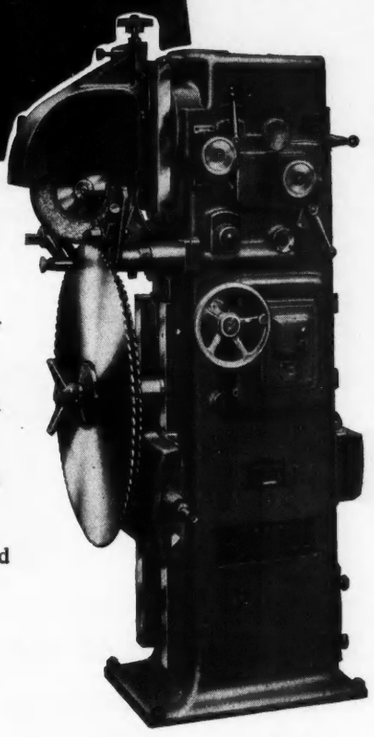

- Tooth form (variable) automatically generated
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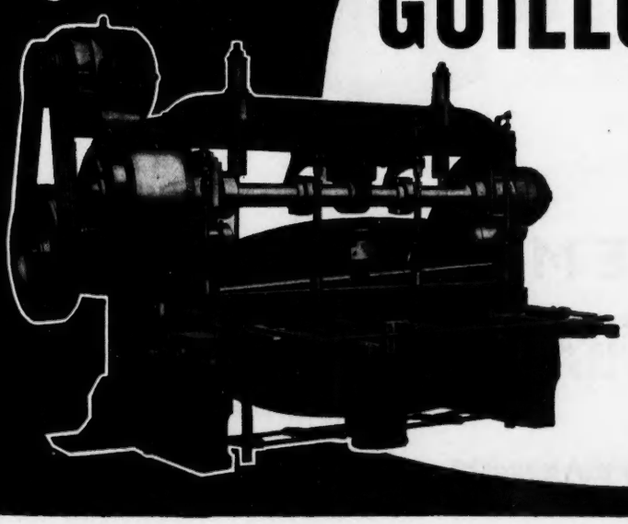

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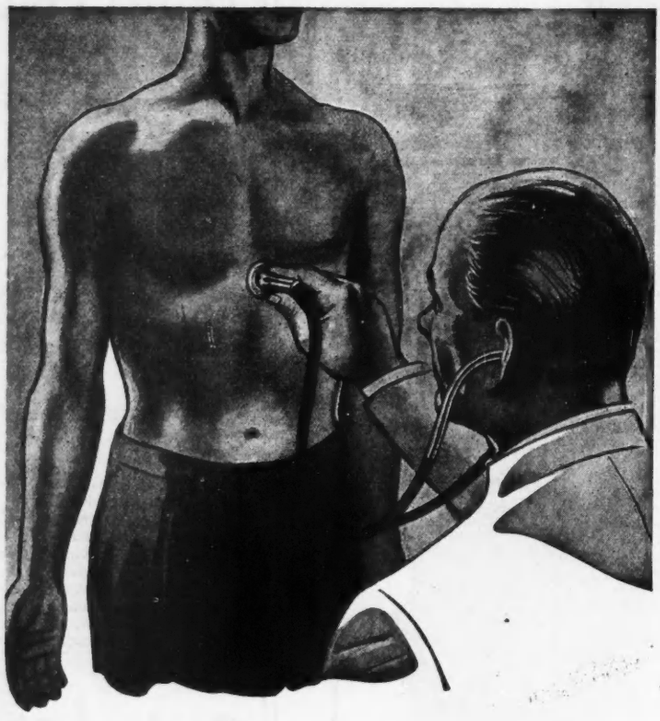

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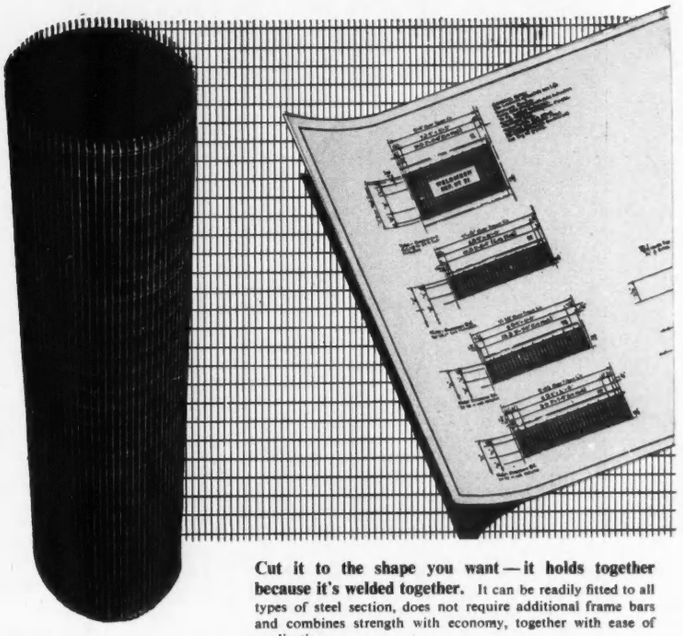

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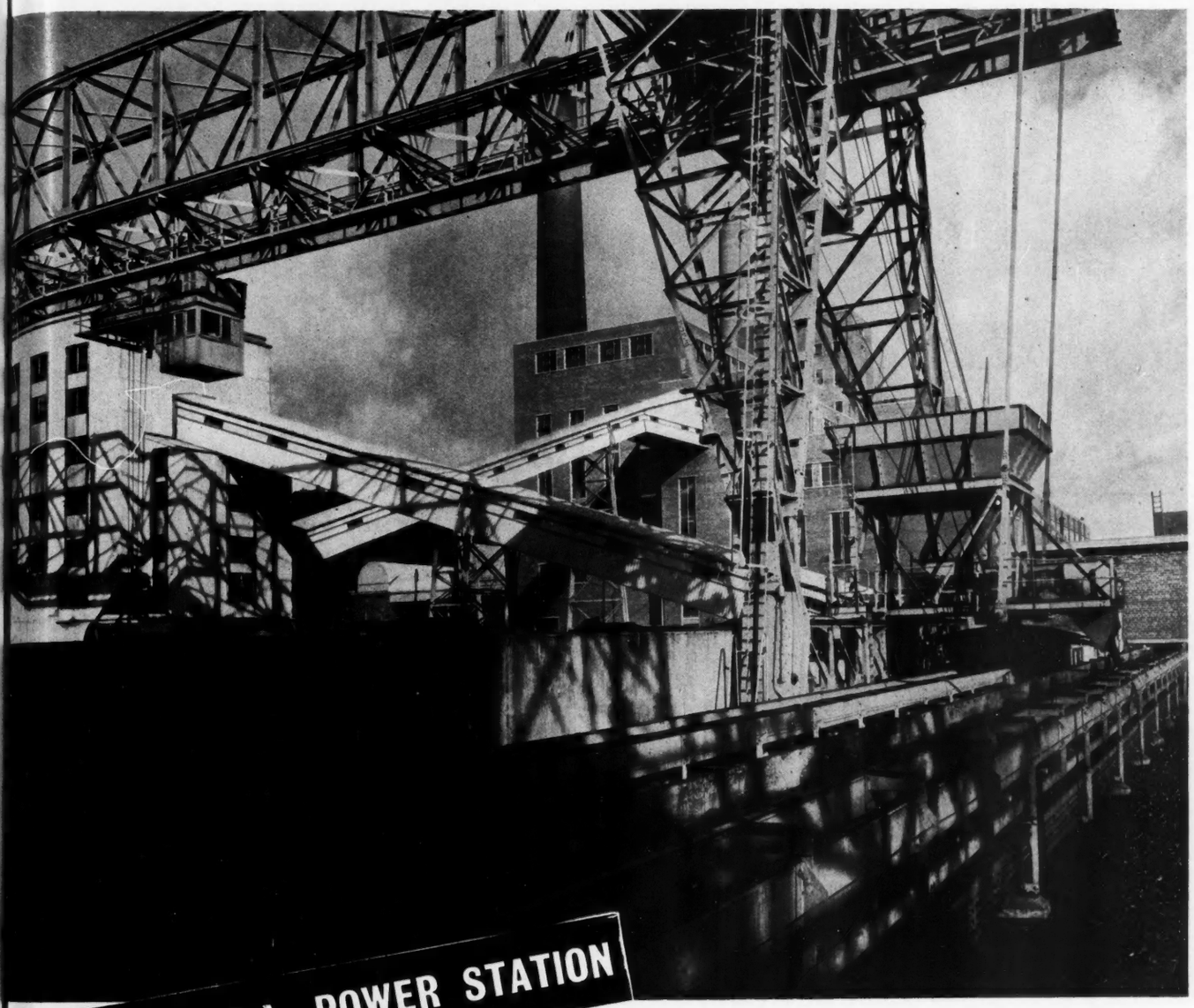
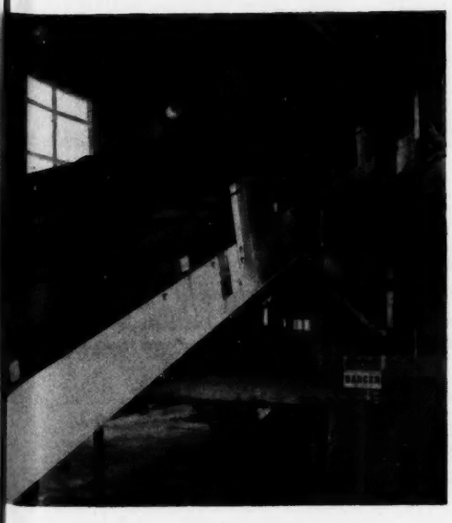


THE NEW C.E.A. POWER STATION AT PORTISHEAD IS EQUIPPED WITH SPENCER PLANT



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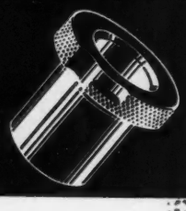
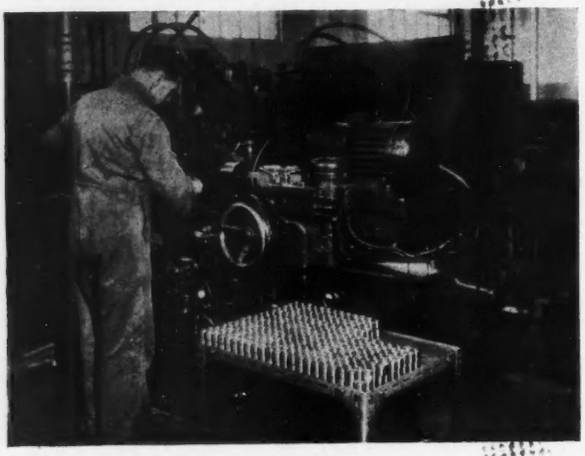


the best bushes — and the set-up that gives the best service



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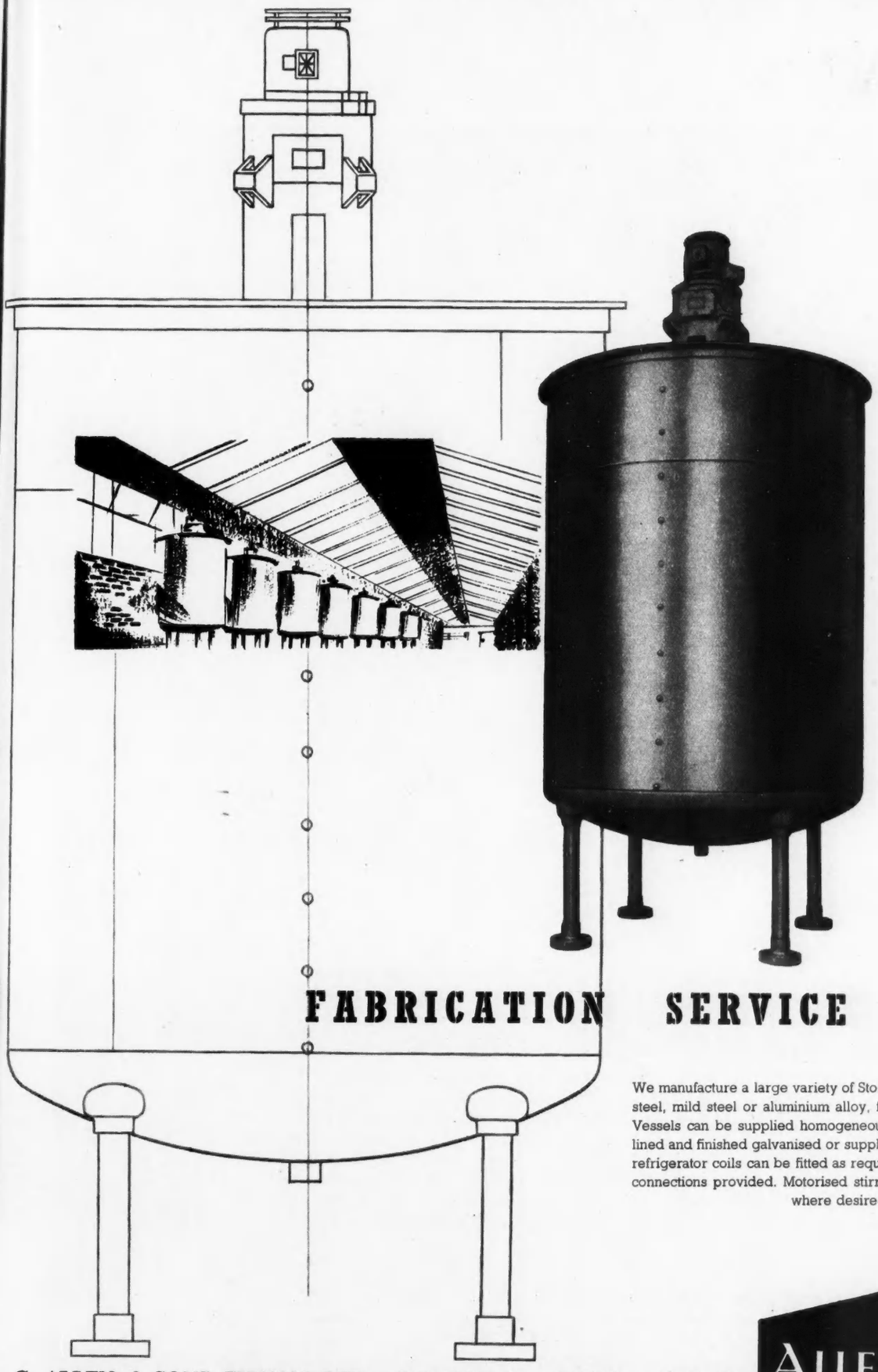

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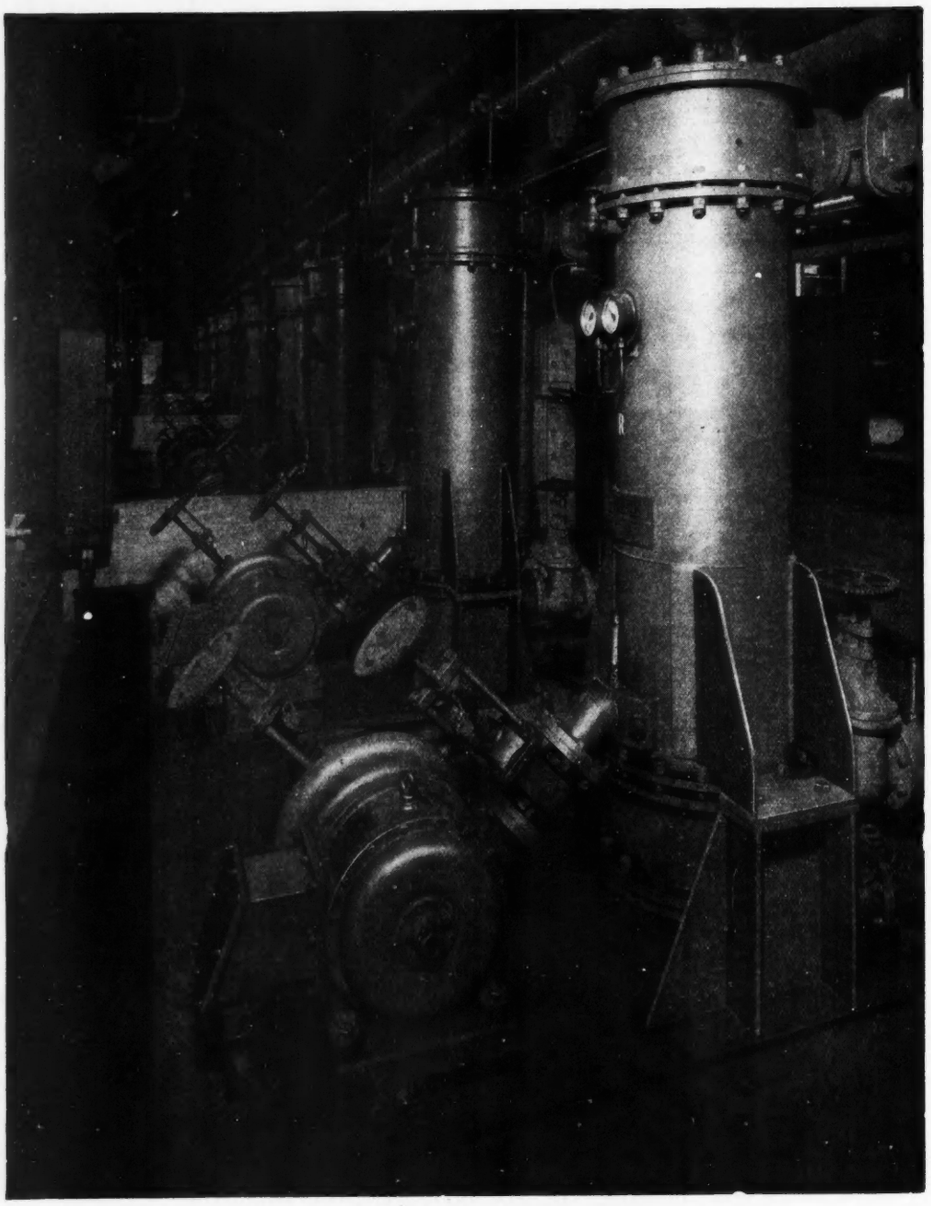

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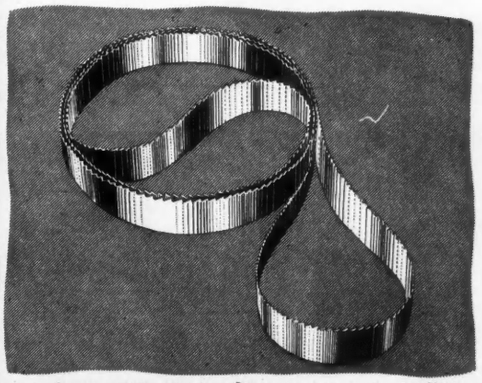

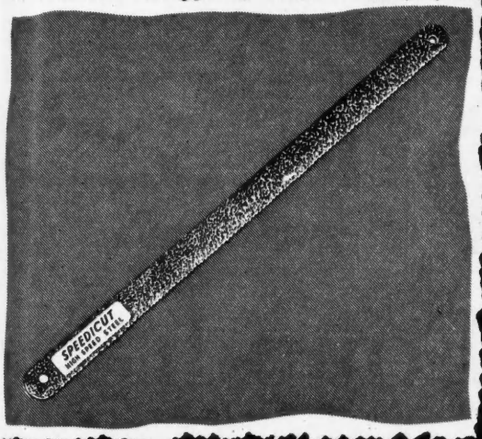

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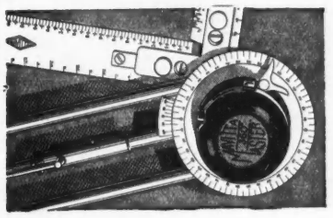

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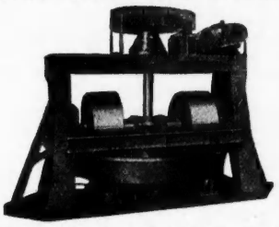

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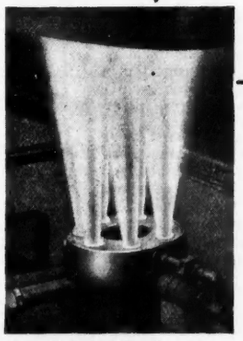

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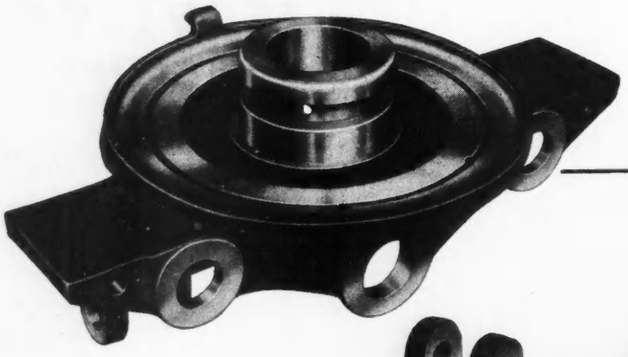

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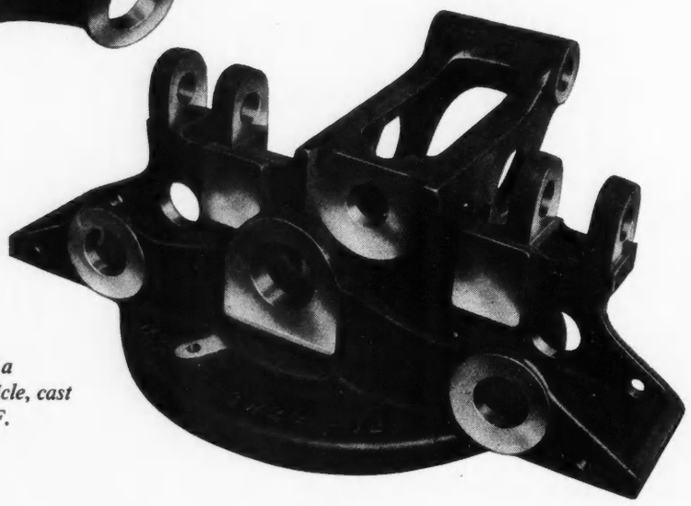

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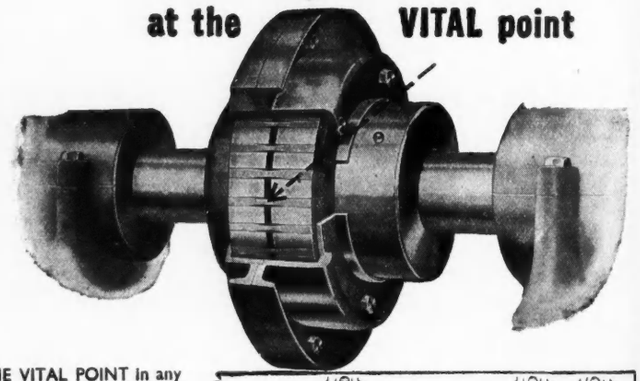

THE VITAL POINT in any power plant is where the shaft of the driving unit links up with the shaft of the unit driven. Vibration, shocks and stresses resulting from misalignment at this point are reflected in loss of power and, eventually, by serious breakdowns.

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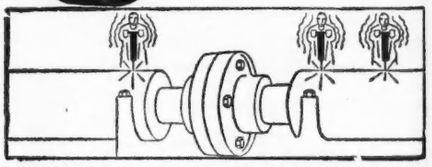
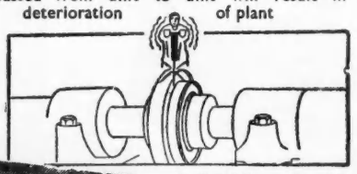


Unless checked, accumulative shocks and stresses passed from unit to unit will result in rapid deterioration of plant



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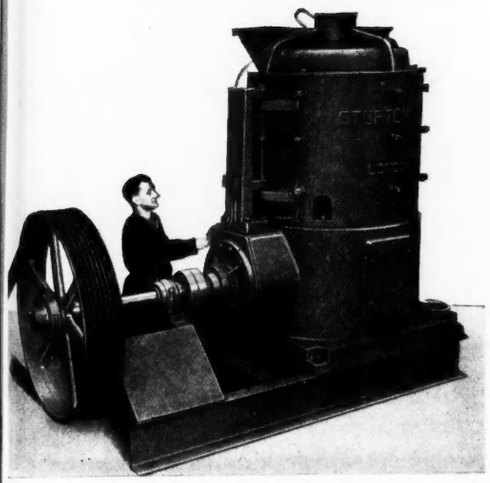
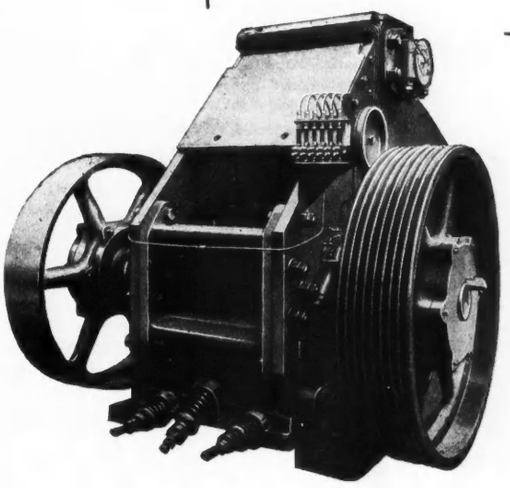
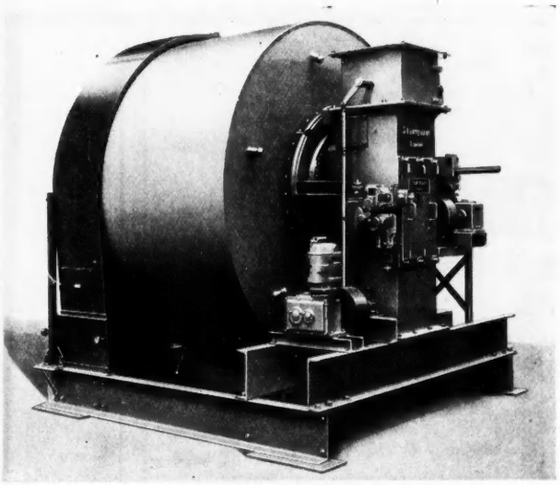


A Sturtevant Rotary Fine Crusher for reducing a large range of moderately hard and soft materials.



This Sturtevant 20 in. by 30 in. Roll Jaw Coarse Crusher treats very hard pyrites at a rate of 18-20 tons per hour. This size has a production capacity up to approximately 75 tons per hour depending upon the material handled.



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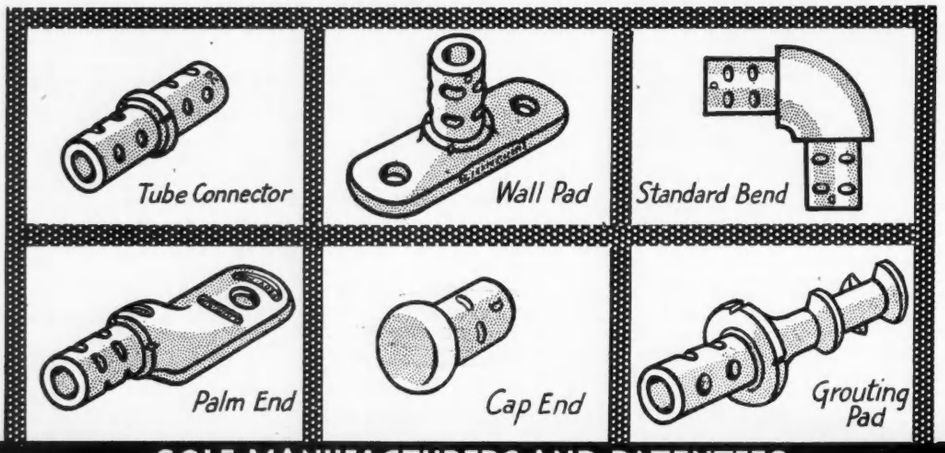

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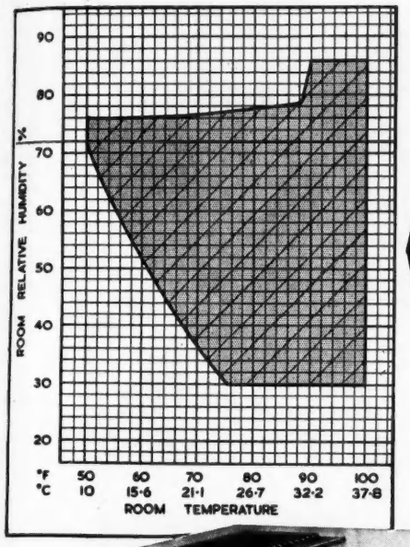

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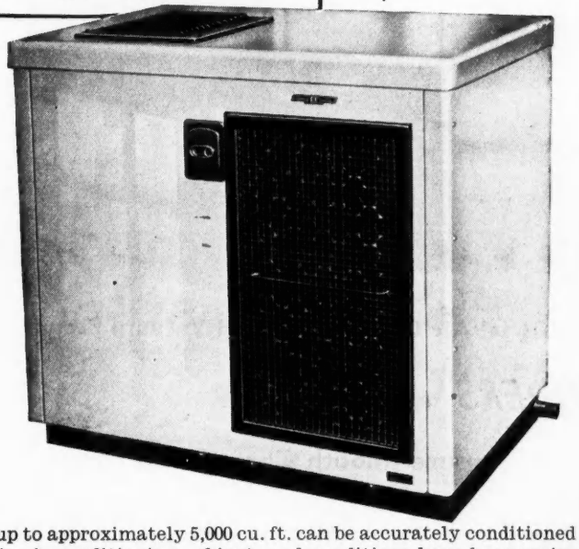

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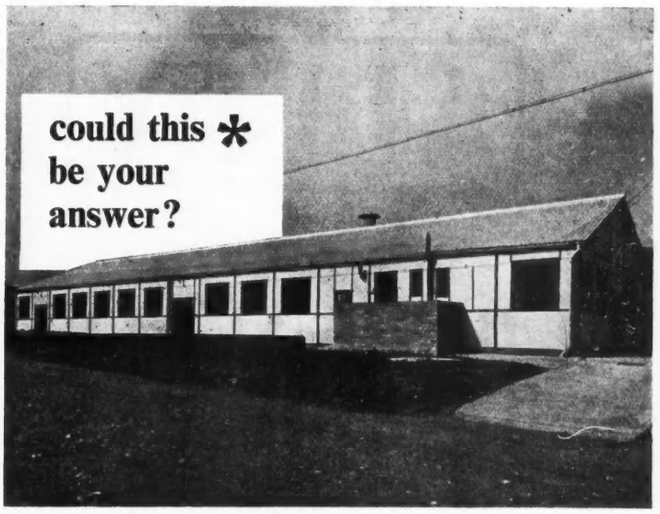

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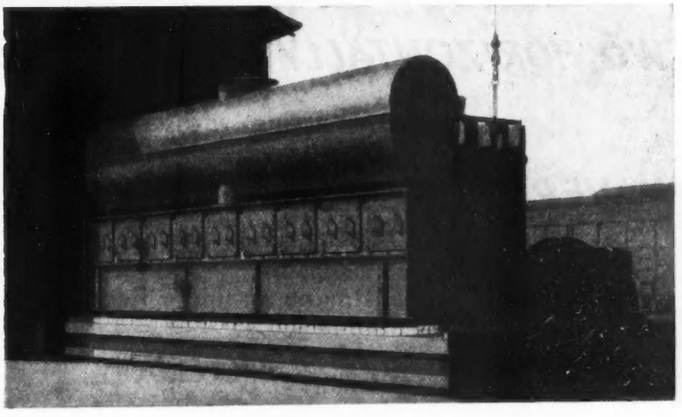

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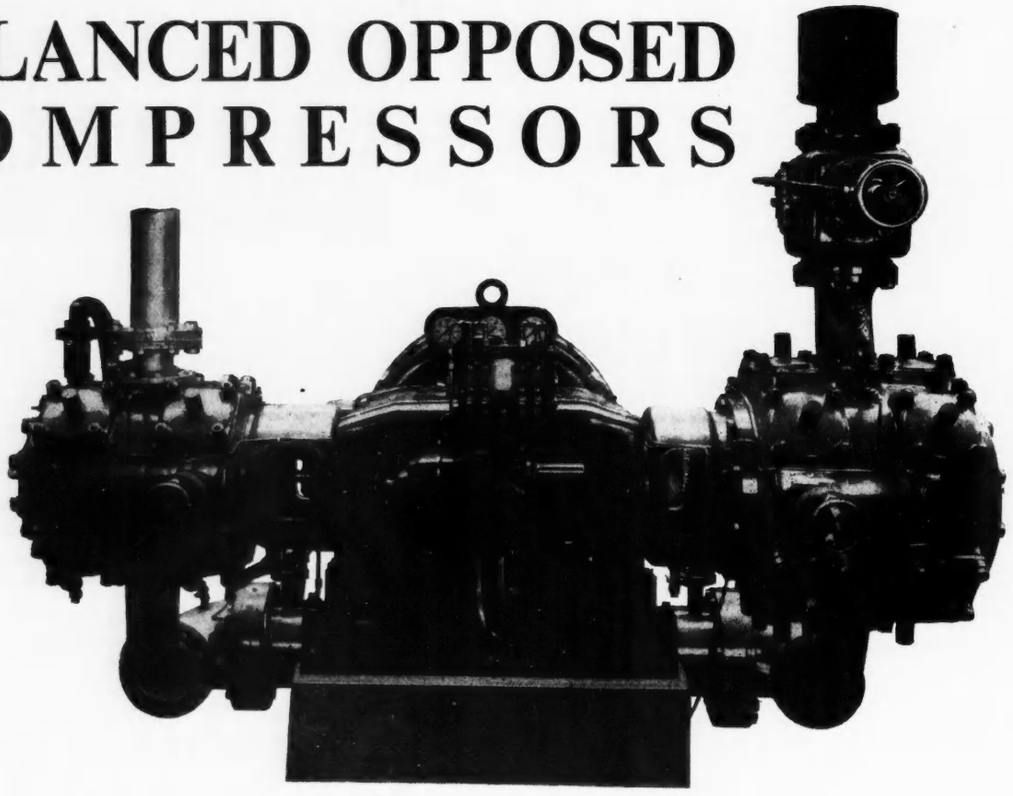

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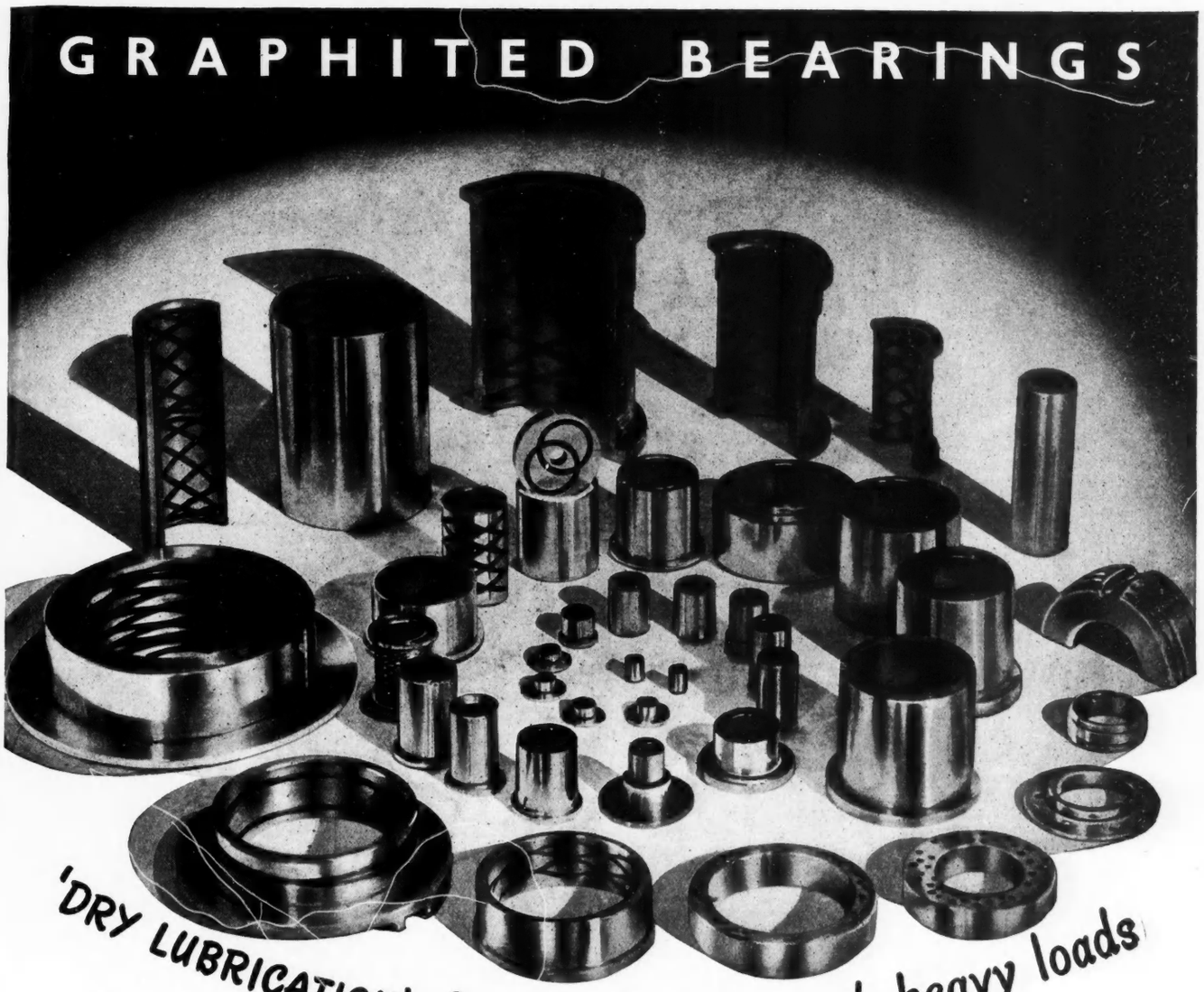

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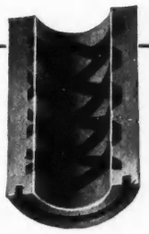

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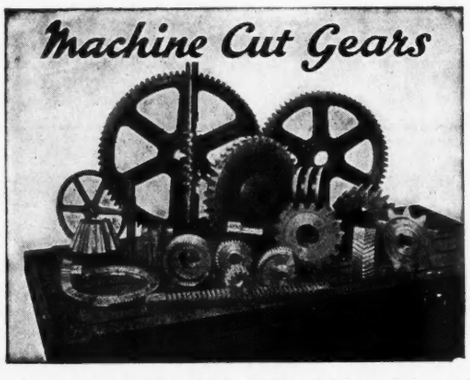

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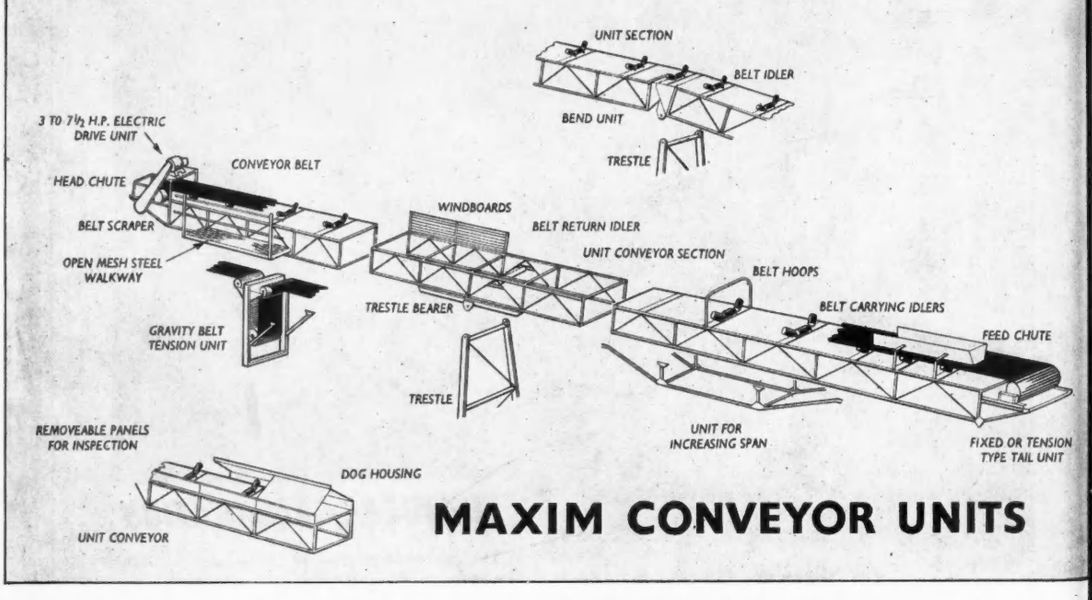

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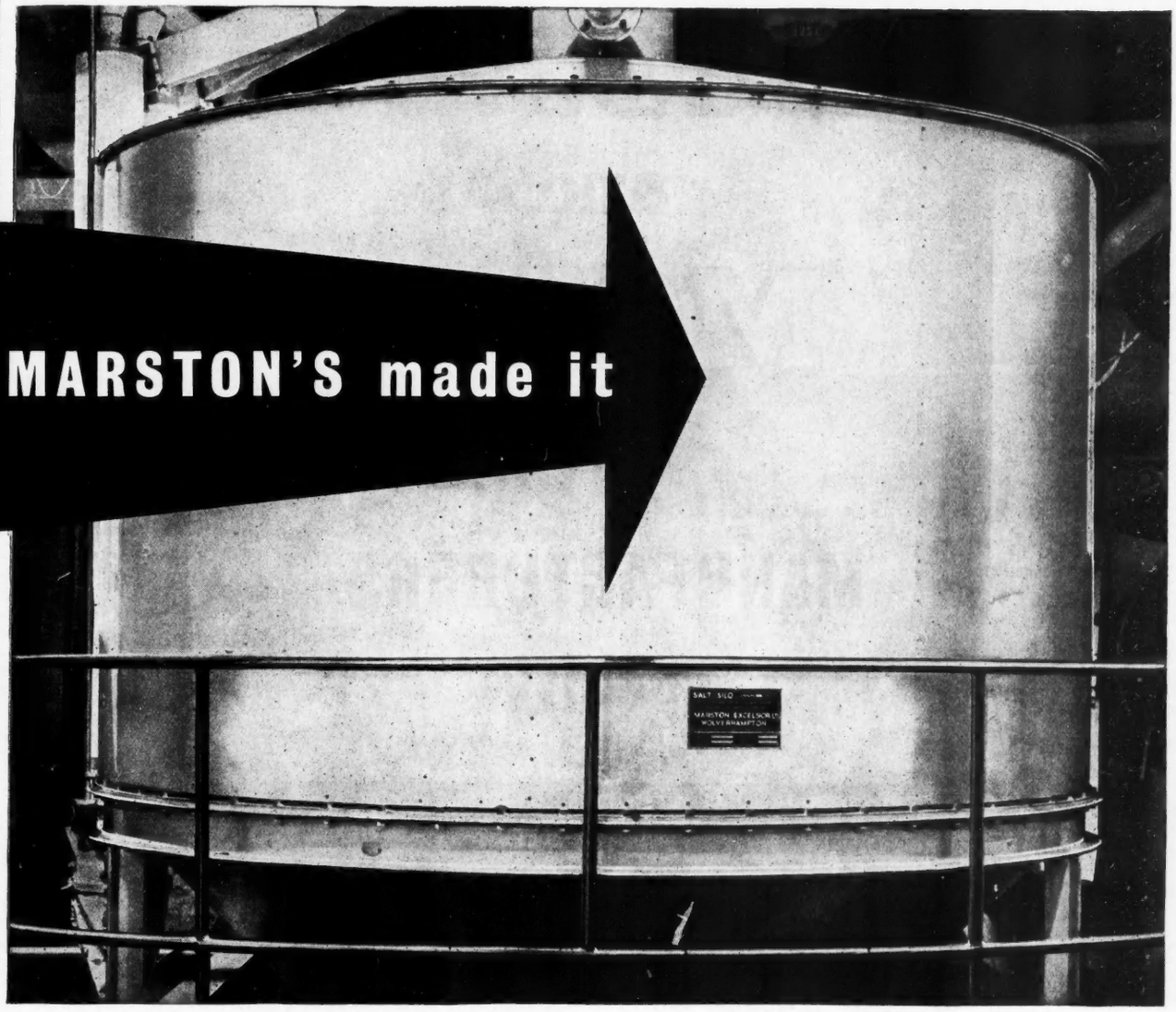

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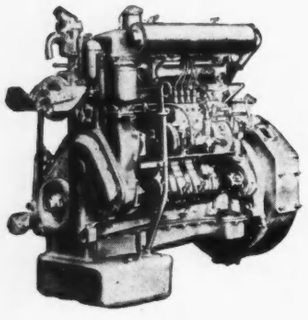

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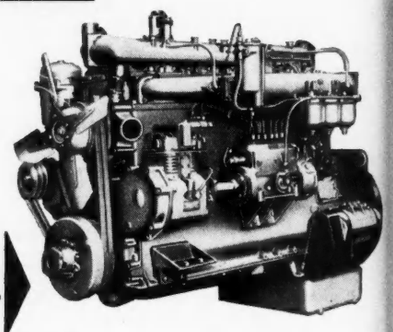

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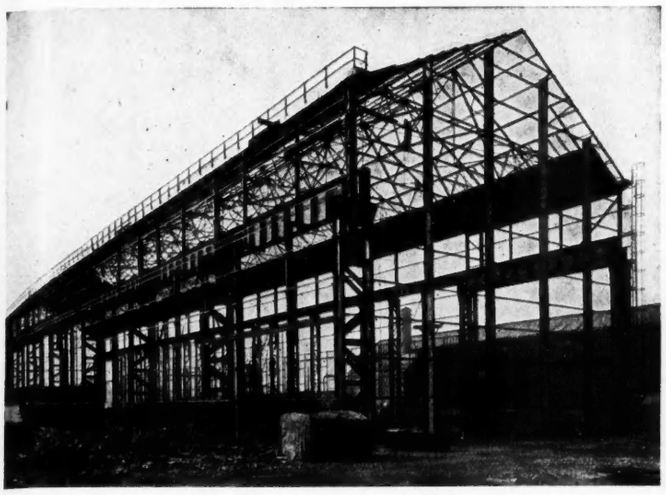

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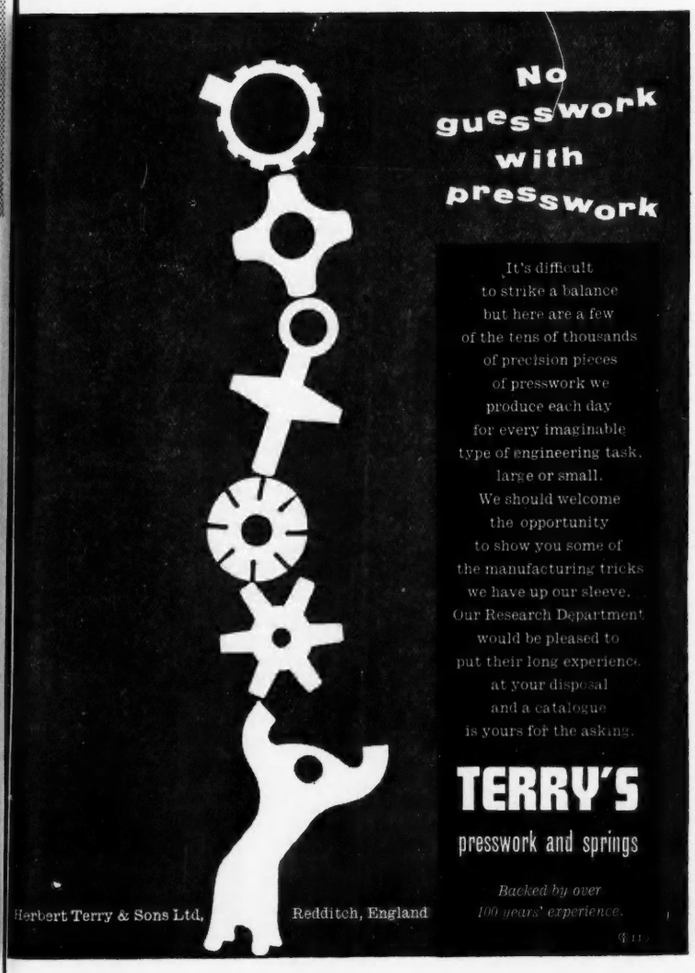
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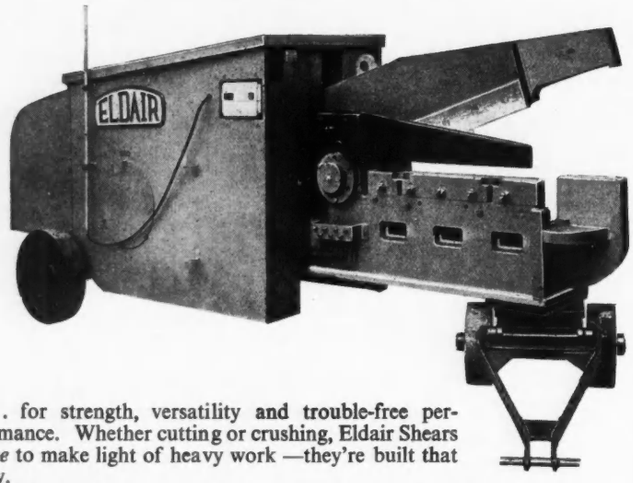

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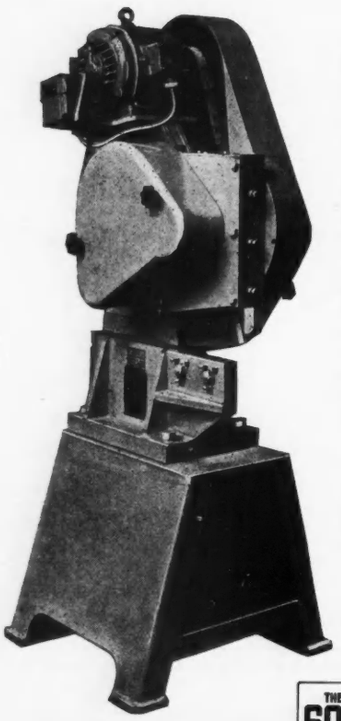

MODEL "1"
Capacity to shear 24″×½″ flats, 2″ rounds, 1¾″ squares, 15″×¾″ bars, blade length 24″.

MODEL "01" (as illustrated above)
Capacity to shear 12″×¾″ flats, 1½″ rounds, 1¼″ squares, 8″×¾″ bars, blade length 30½″.

MODEL "00"
Capacity to shear 12″×½″ flats, 1½″ rounds, 1″ squares, 9″×½″ bars, blade length 30½″.

MODEL "0"
Capacity to shear 12″×½″ flats, 1½″ rounds, 1″ squares, 9″×½″ bars, blade length 12″.

MODEL "CUB" (as illustrated on left)
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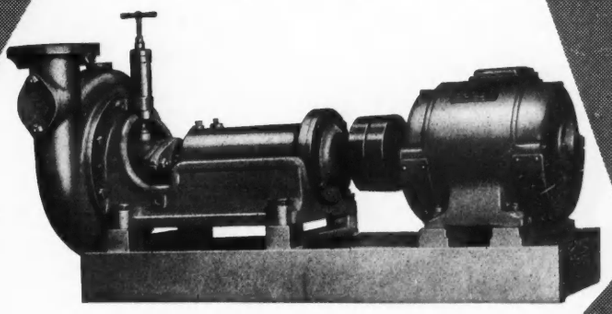

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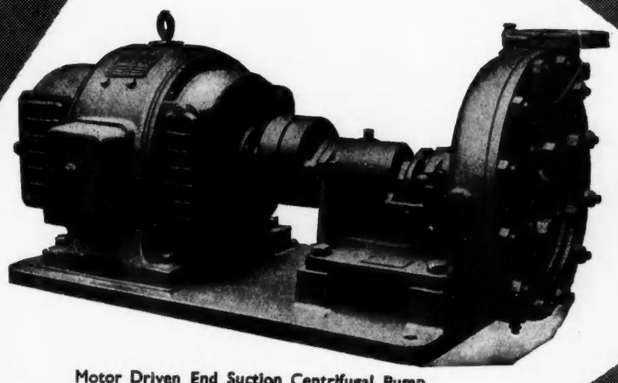

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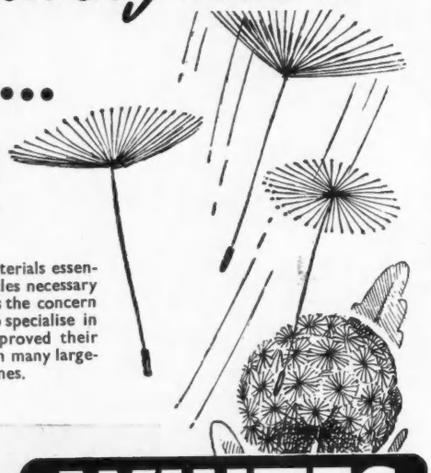

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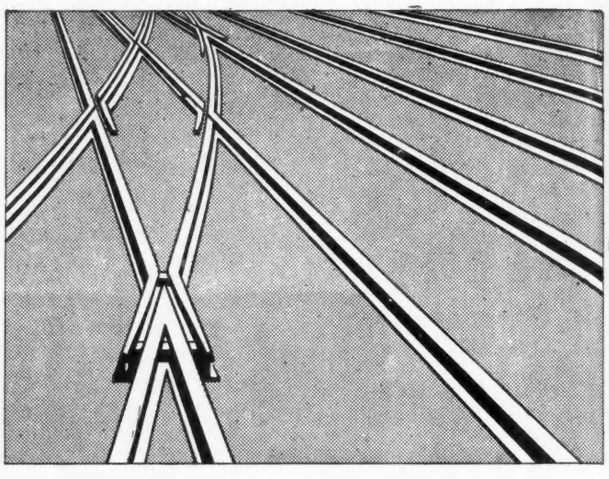

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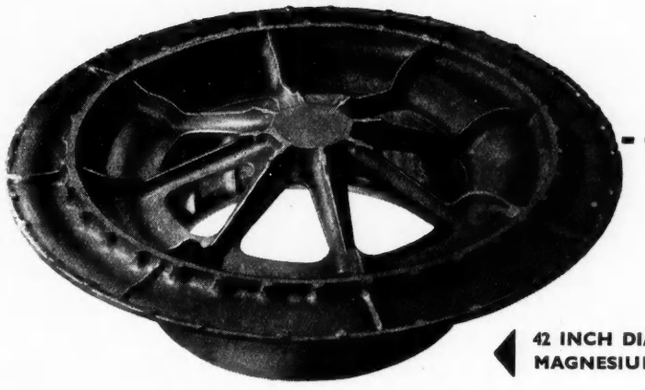

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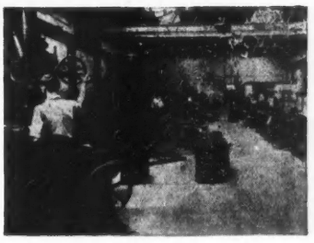

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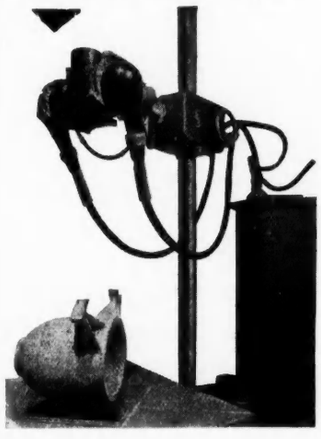

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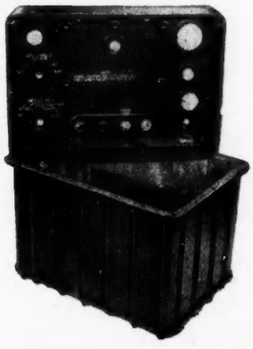

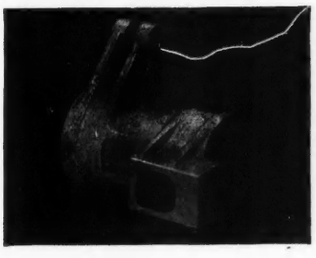

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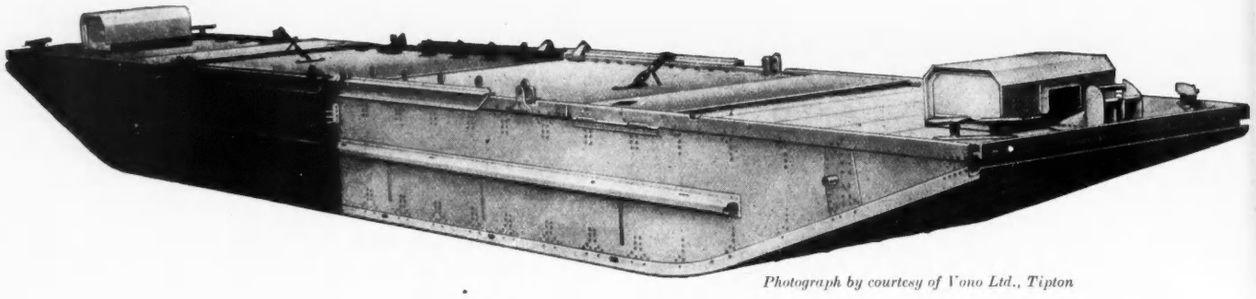

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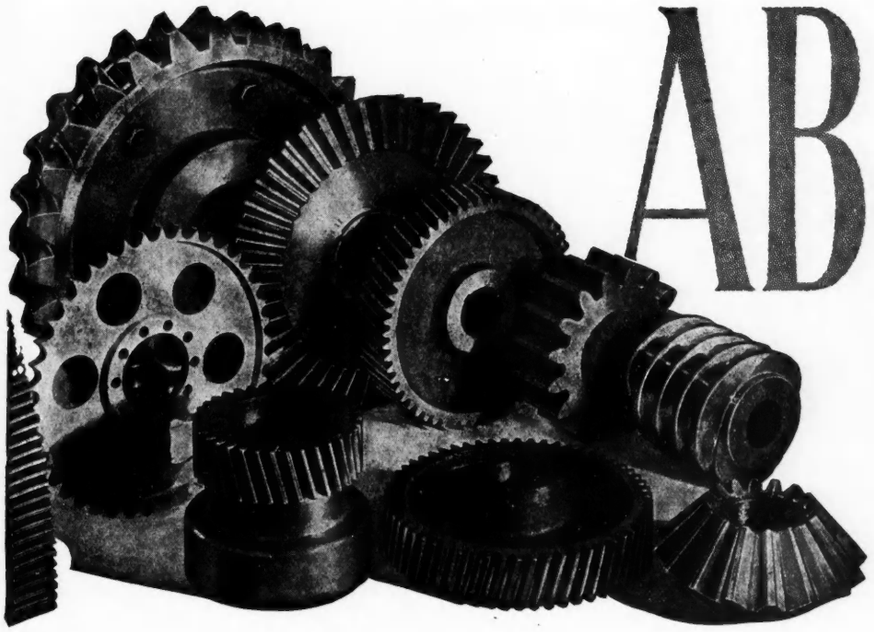

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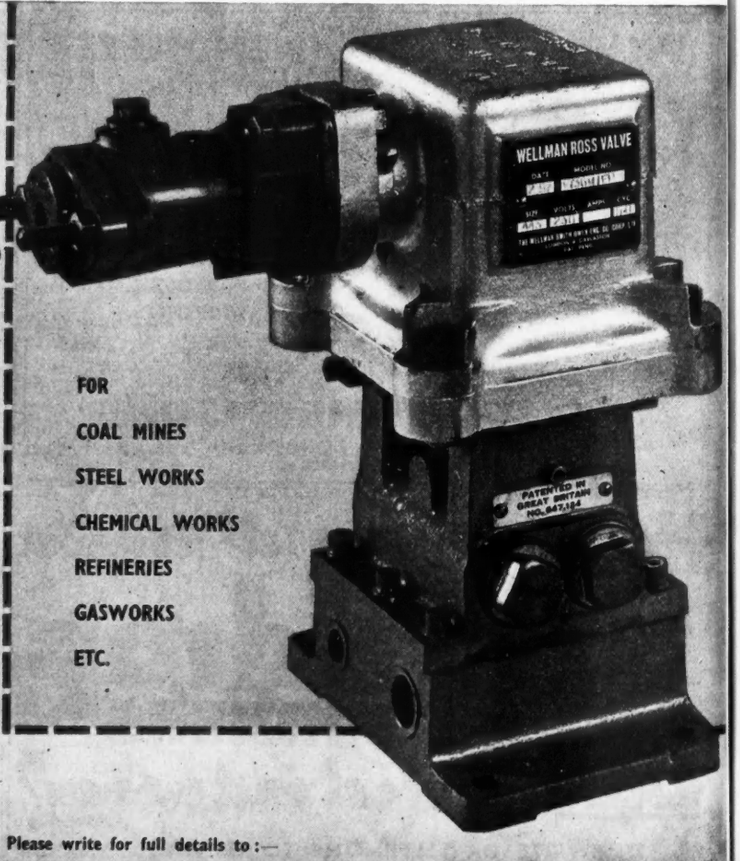

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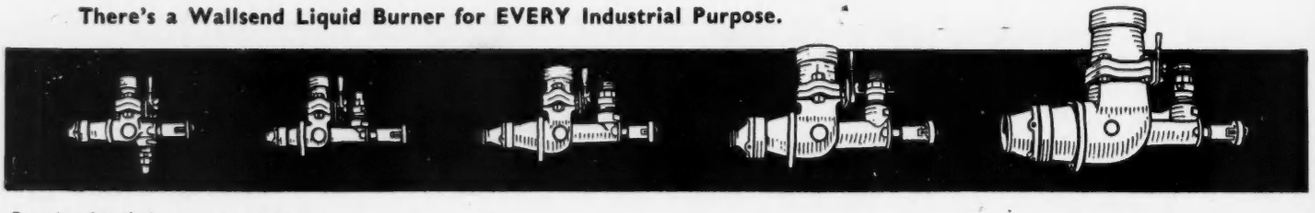

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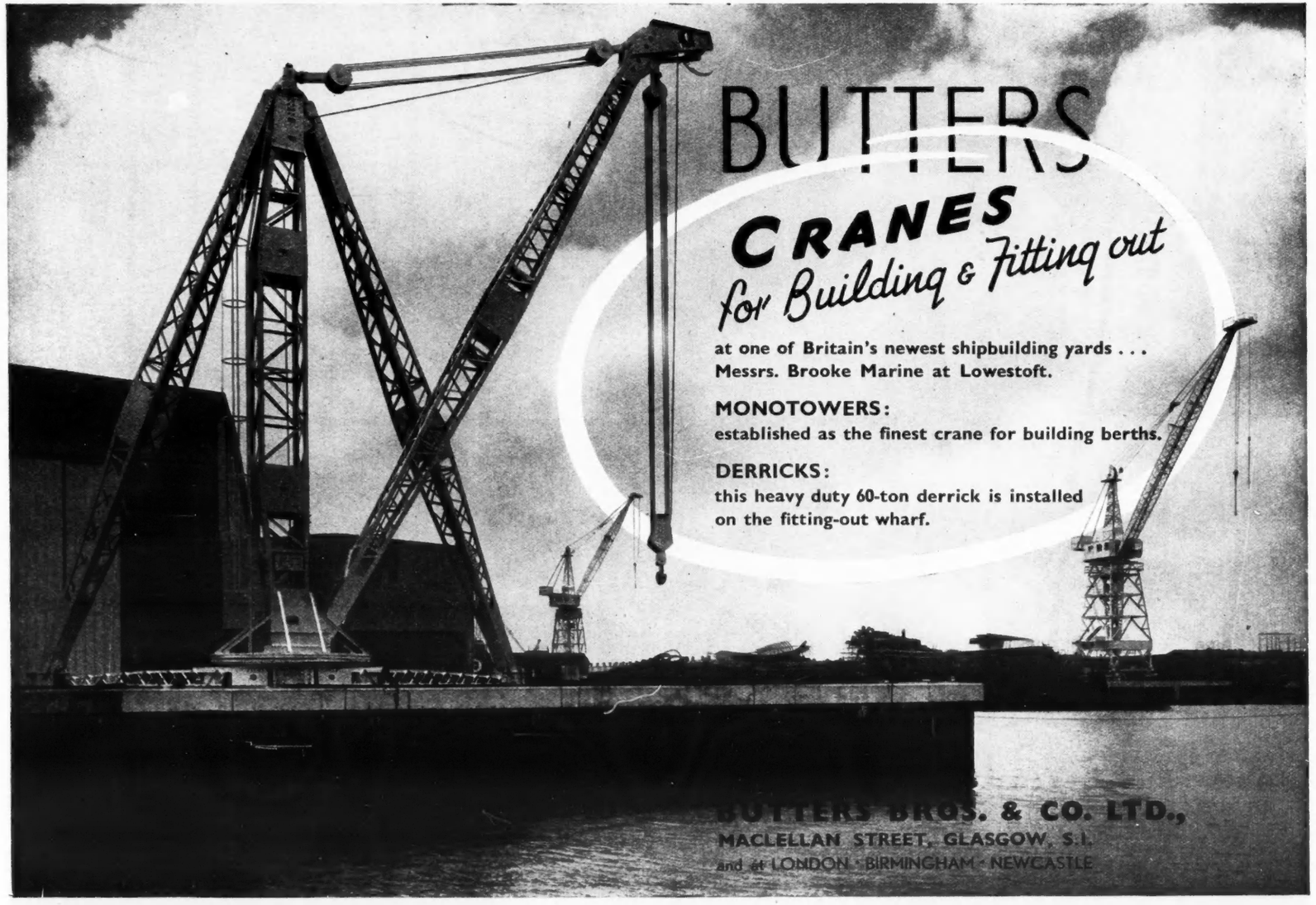
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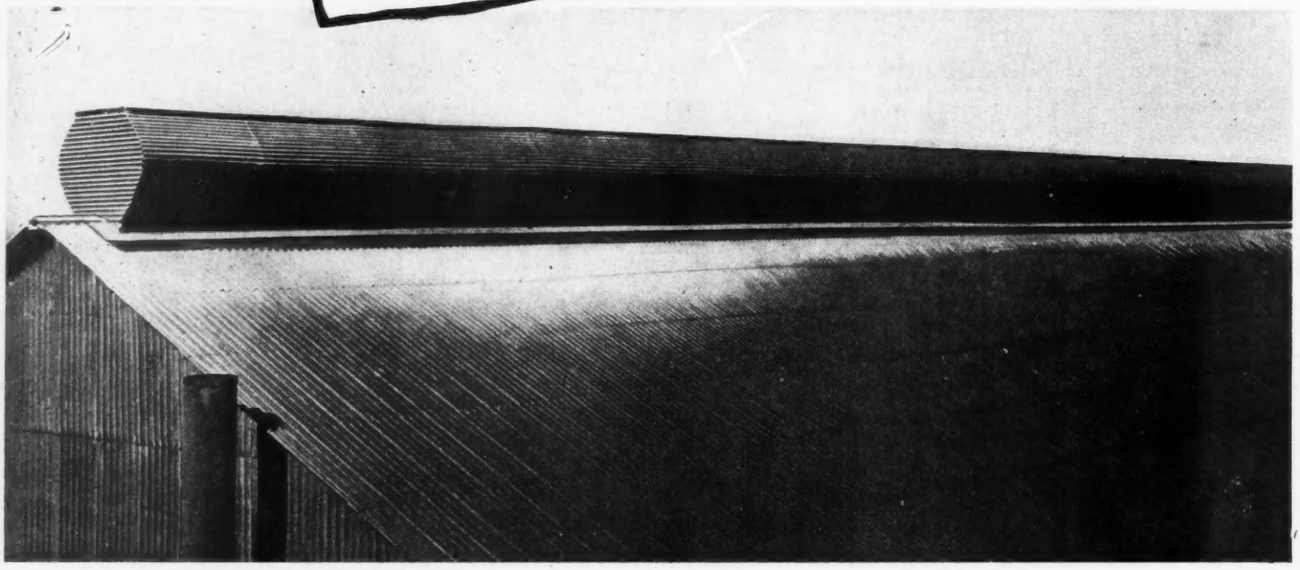

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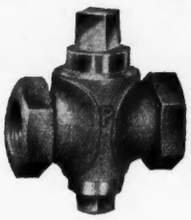
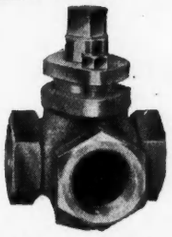
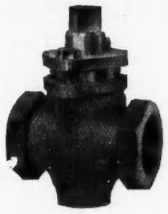


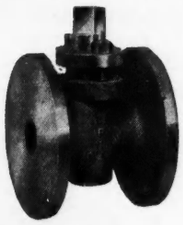
1081 Gunmetal plug cock. Female ends tapped BSPT (Taper) (BS21). For steam pressures up to 150 lbs. p.s.i. ¼"—3". 1082 for pressures up to 200 lbs. p.s.i. ¼"—2".



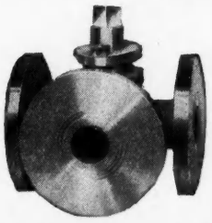
1111 Gunmetal threeway gland cock. ("T" or "L" Port). Female ends tapped BSPT (Taper) (BS21). For pressures up to 150 lbs. p.s.i. ¼"—2".



1090 Gunmetal gland cock. Female ends tapped BSPT (Taper) (BS21). For pressures up to 150 lbs. p.s.i. ¼"—3". 1091 for pressures up to 200 lbs. p.s.i. ¼"—2".



1093 Gunmetal flanged gland cock. Flanged to BST "E". For Steam pressures up to 100 lbs. p.s.i. 1"—3".



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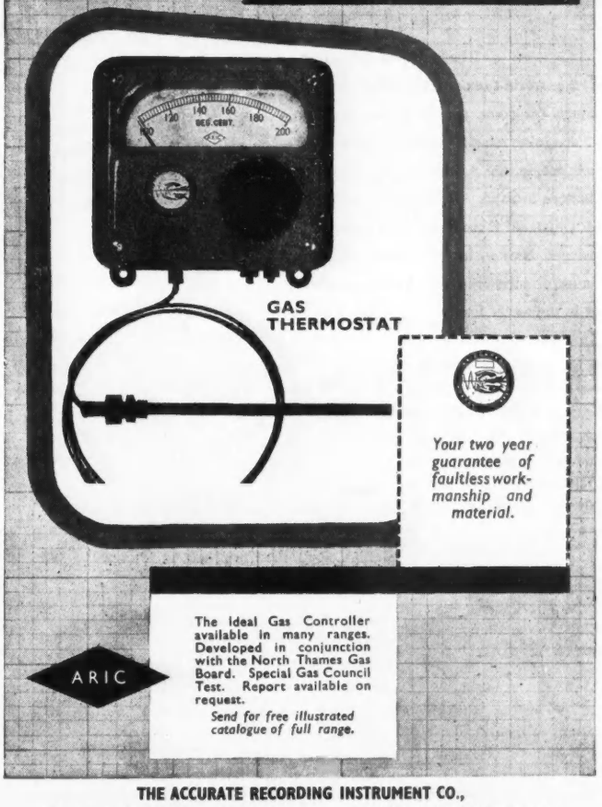
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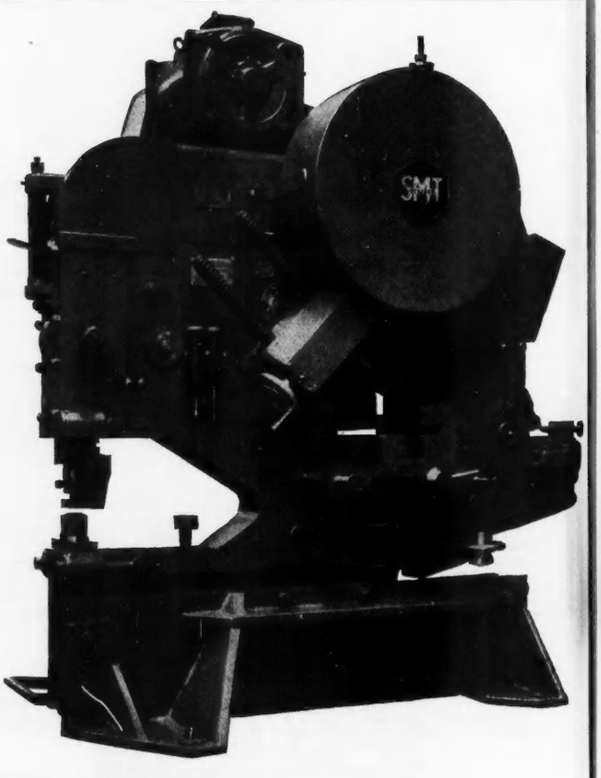

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10	⅝in.	1in. thro' ⅝in.	4½in. × ½in.	4in. × ⅜in.	1½in.	1½in.	⅜in.
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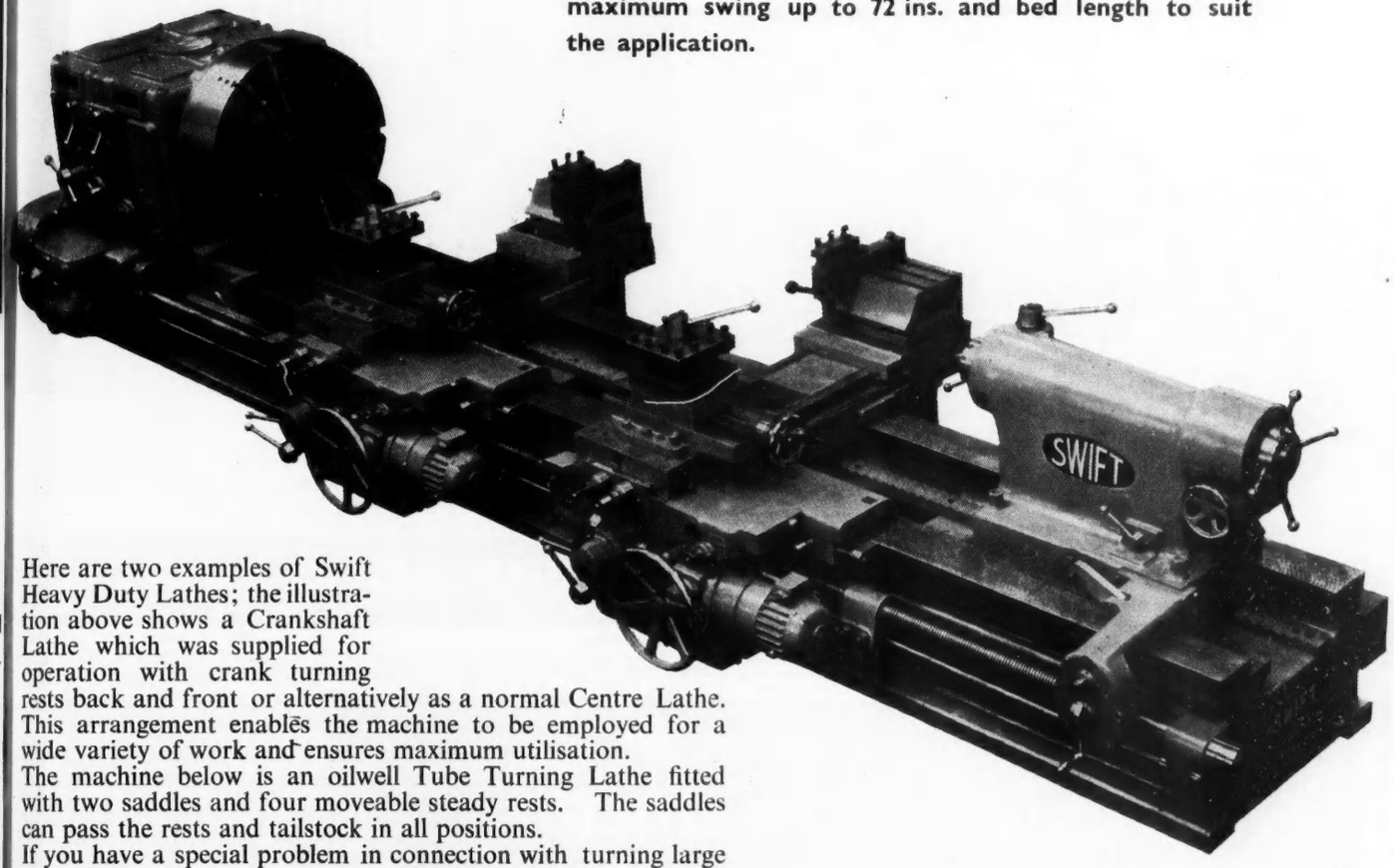

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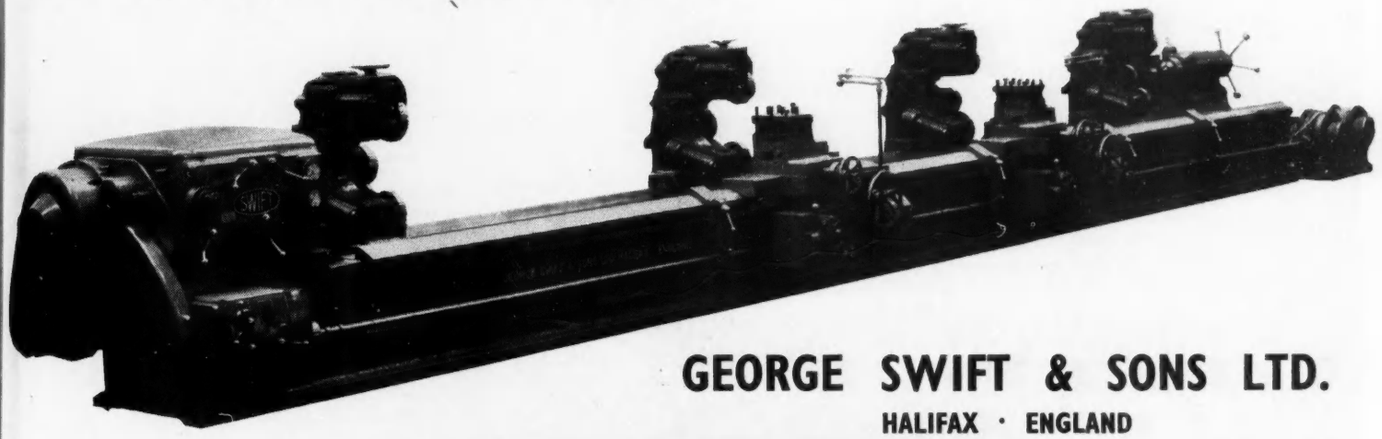

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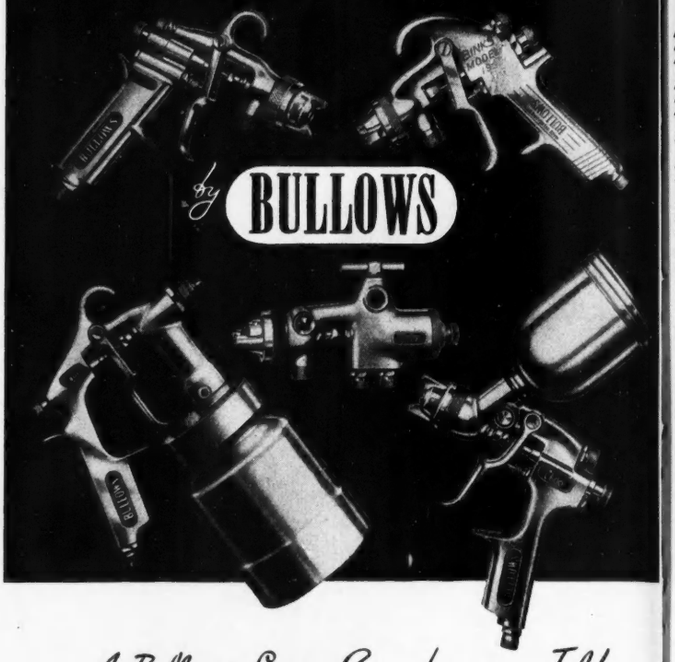

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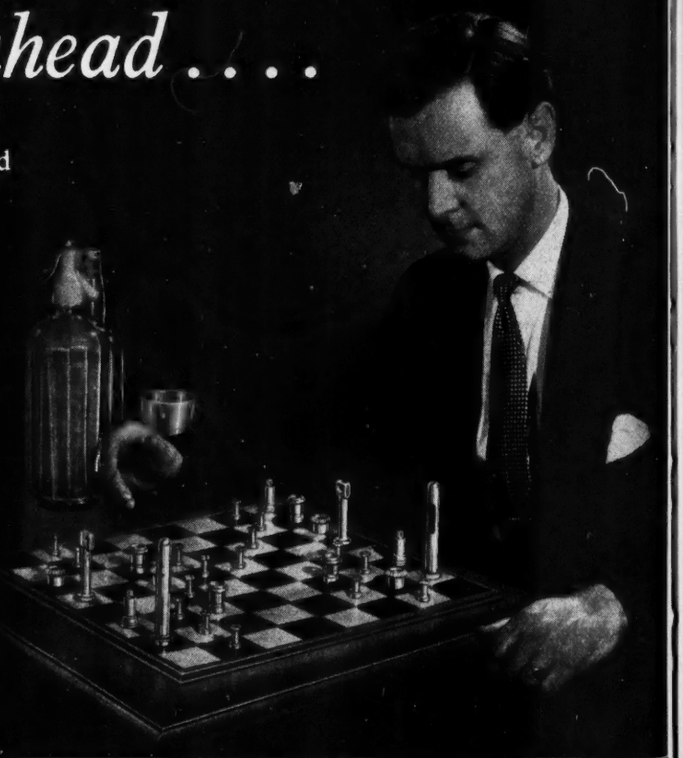

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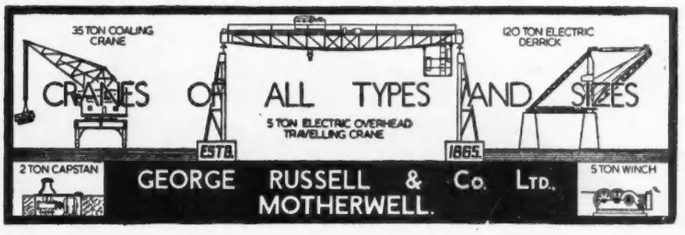

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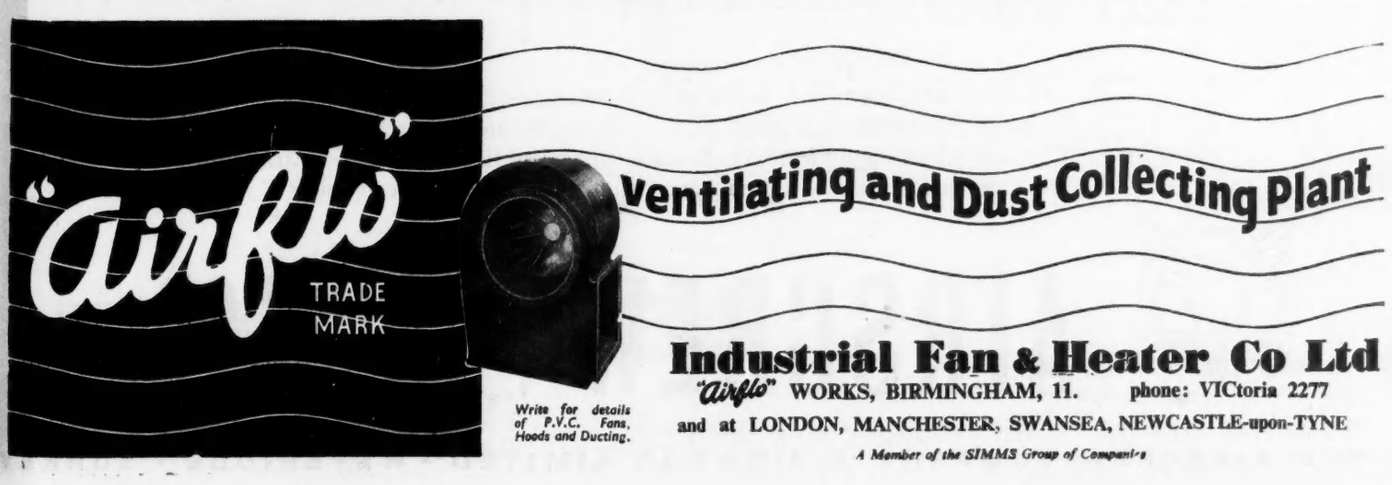
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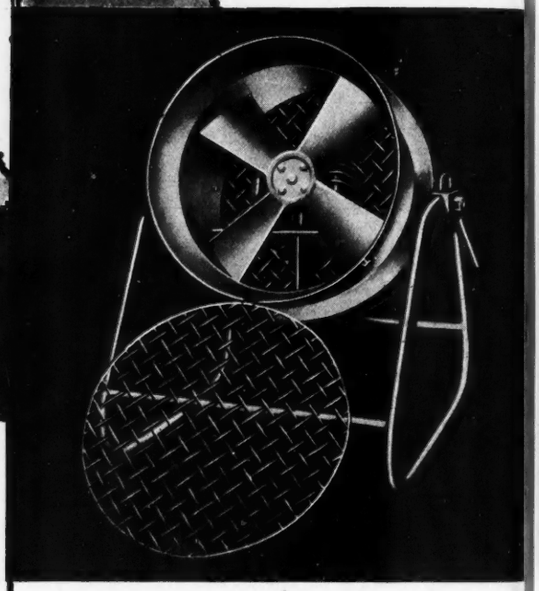

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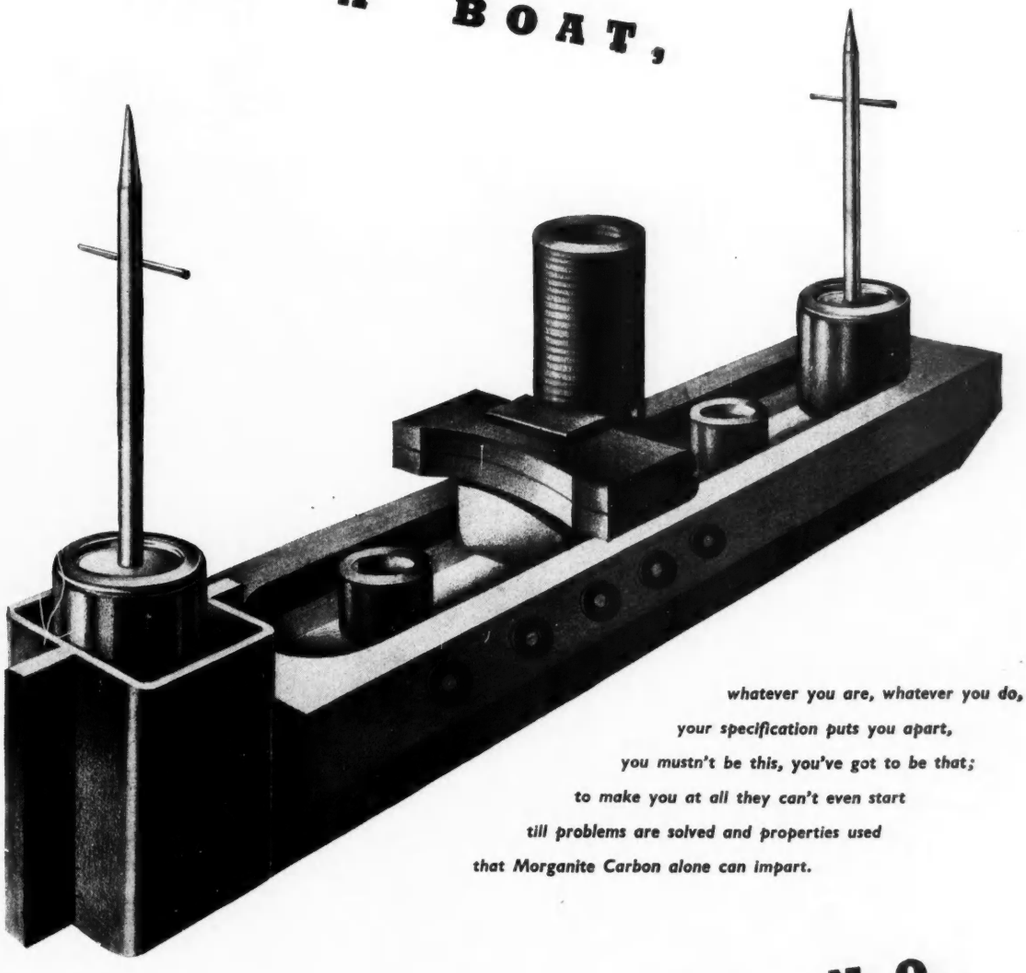

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till problems are solved and properties used
that Morganite Carbon alone can impart.

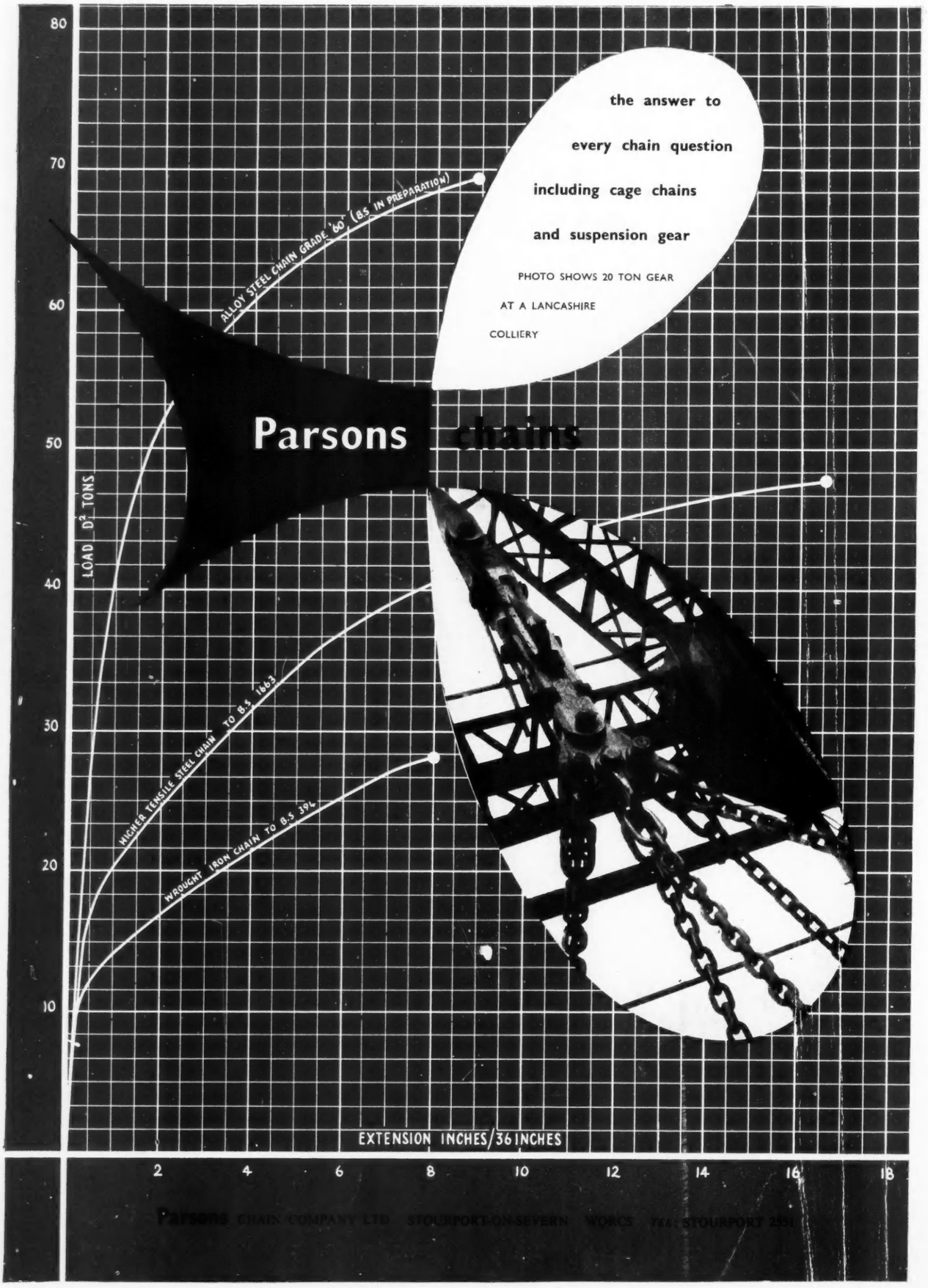
For the design engineer Morganite Carbon is a material with a vast potentiality; some of its properties are unique, many can be varied to obtain specific characteristics. A material which is strong as steel but light as aluminium, which is self lubricating, has some exceptional electrical properties yet is non-metallic, must have a multiplicity of applications. When you have read the other properties of Morganite Carbon, why not have a talk with our technical staff? They may be able to help with **your** problem.

OTHER PROPERTIES INCLUDE:
High resistance to wear. Wide range of resistance to chemical attack. Machinability. Good thermal conductivity. Not wetted by molten metal or slags. Non-seizing. Non-galling. Good mechanical strength at high temperatures. Good electrical conductivity. Available in impervious forms. Low thermal expansion.

MORGANITE CARBON

THE MORGAN CRUCIBLE CO. LTD., BATTERSEA CHURCH ROAD, LONDON, S.W.11 Phone: BAT. 8822

C56/A

The Engineer

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